



Tissue Headbox and Former

Operations and Optimization

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Valmet

Learning Objective

- ✓ Improve understanding on basic principles of sheet forming in a tissue manufacturing process
- ✓ Understand head box criteria of design and how to optimize for best operation
- ✓ Improve trouble solving skills

Topics covered

- Headbox components and their function
- Jet calculation and geometry
- How to improve formation
- Layer purity
- Jet speed curve
- Headbox balance
- Dilution control
- Type of formers in the tissue industry
- Sheet width adjustment

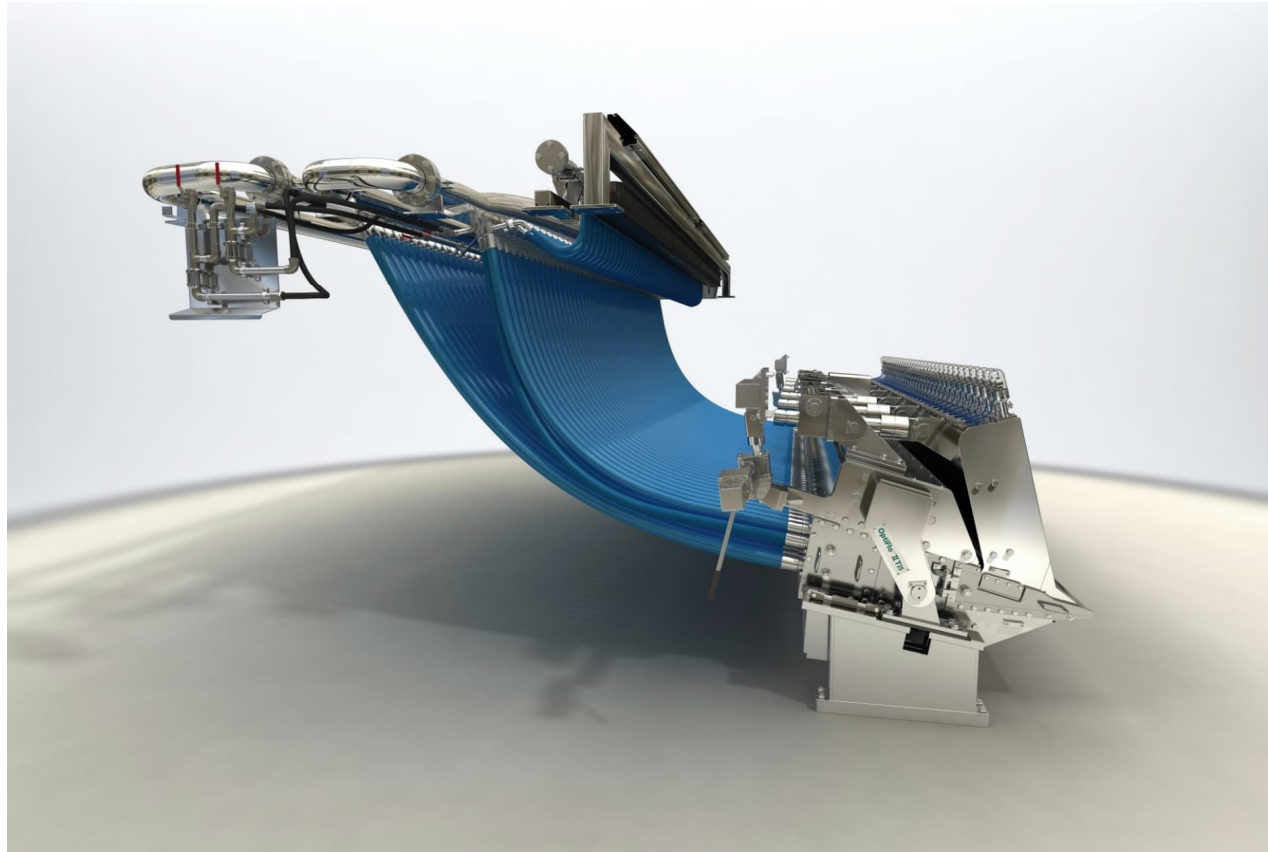
Not covered by
this
presentation

- Stock preparation
- Stock injection
- Mechanical showering
- Clothing design

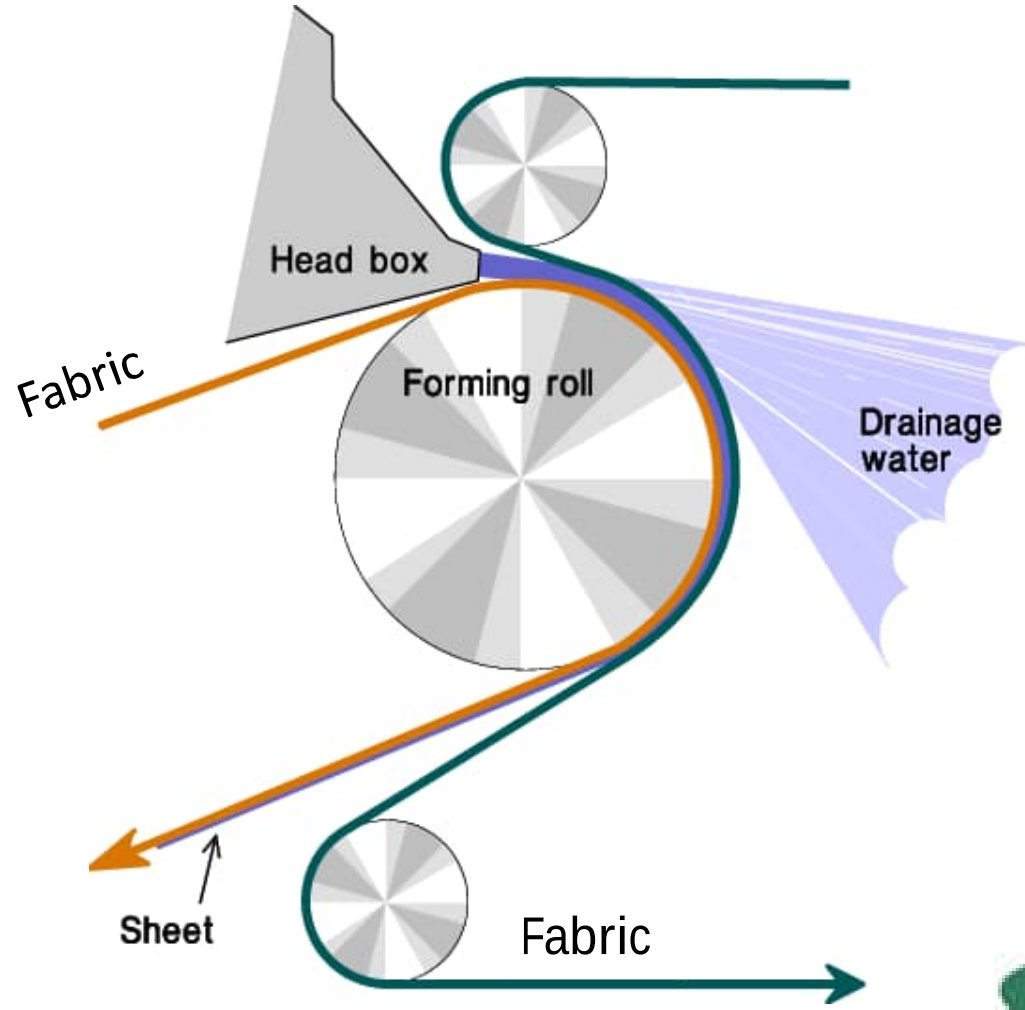
Tissue Machine Headbox and Former



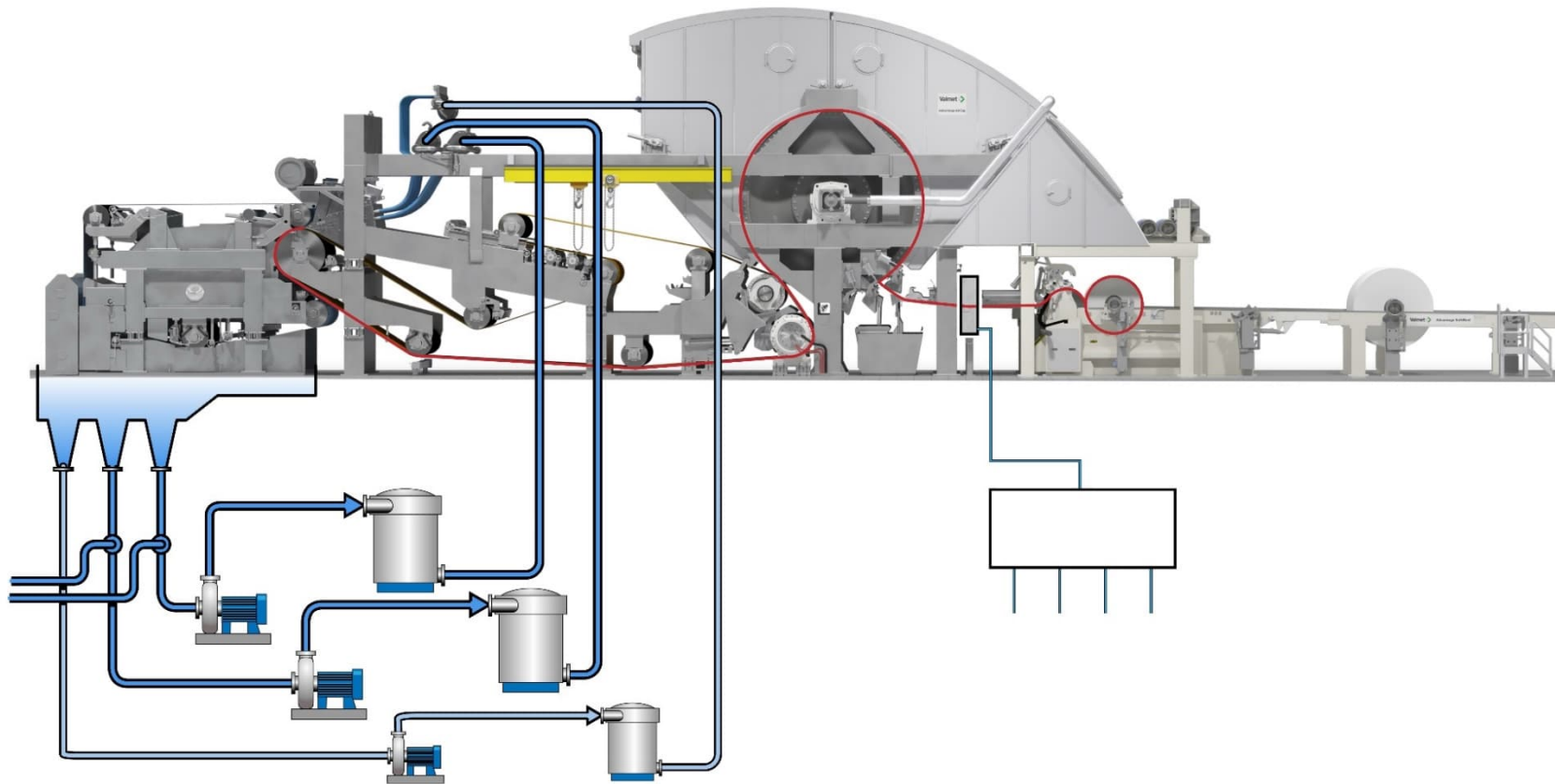
Tissue Headbox Design and Operation



Tissue Headbox and Former Design and Operation

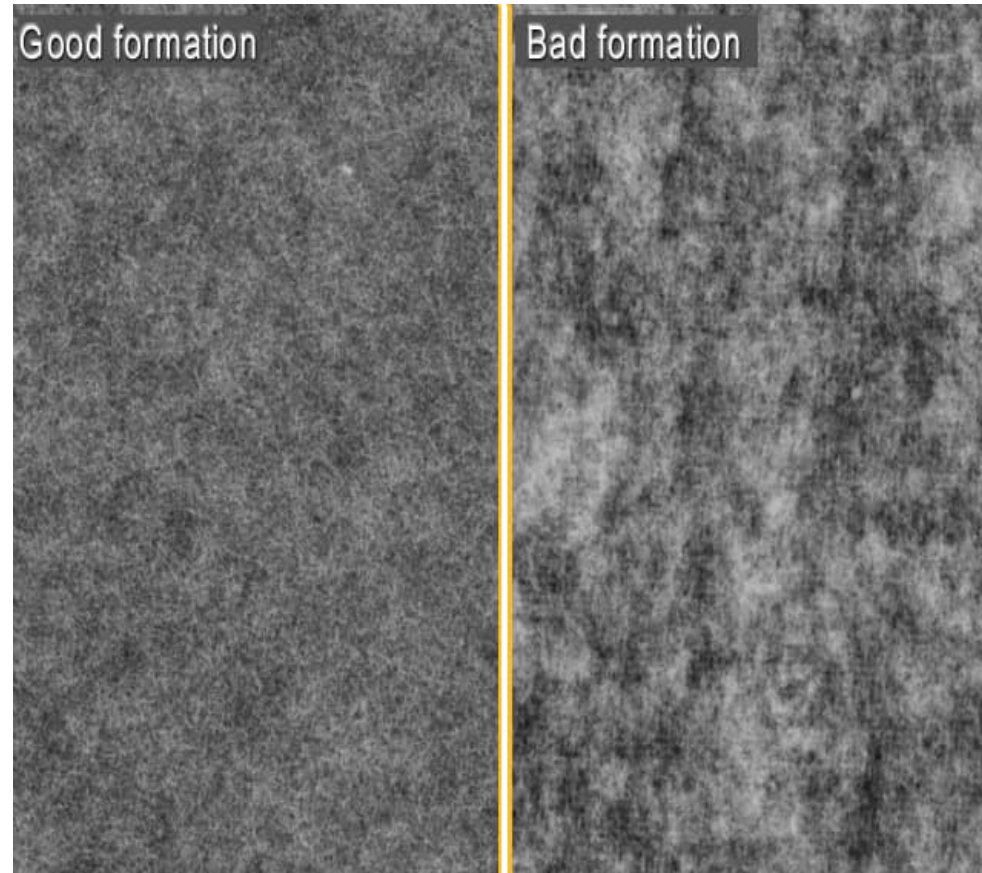


Approach System 2-Layer with dilution



Headbox for Tissue Requirements:

- Uniform basis weight profile
- Sheet formation
- Fiber orientation (MD/CD) uniformity
- Clean design
- Layering capability
- Stable jet geometry



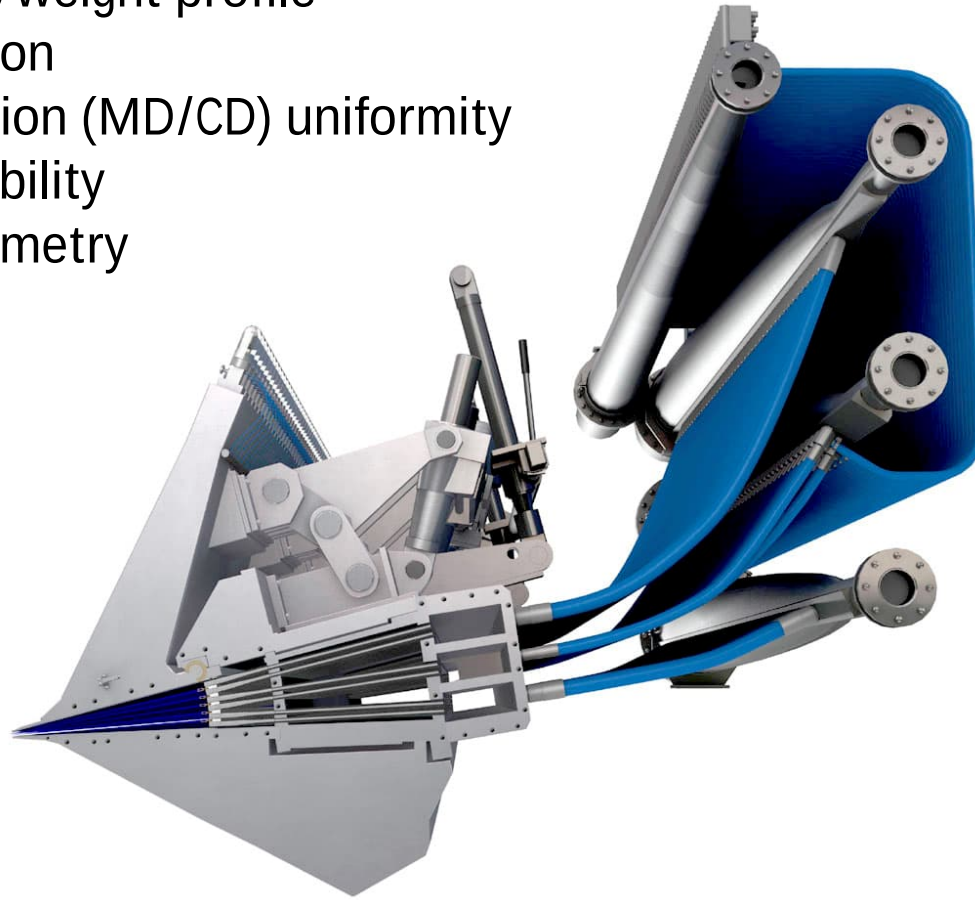
Tissue Headbox

Description

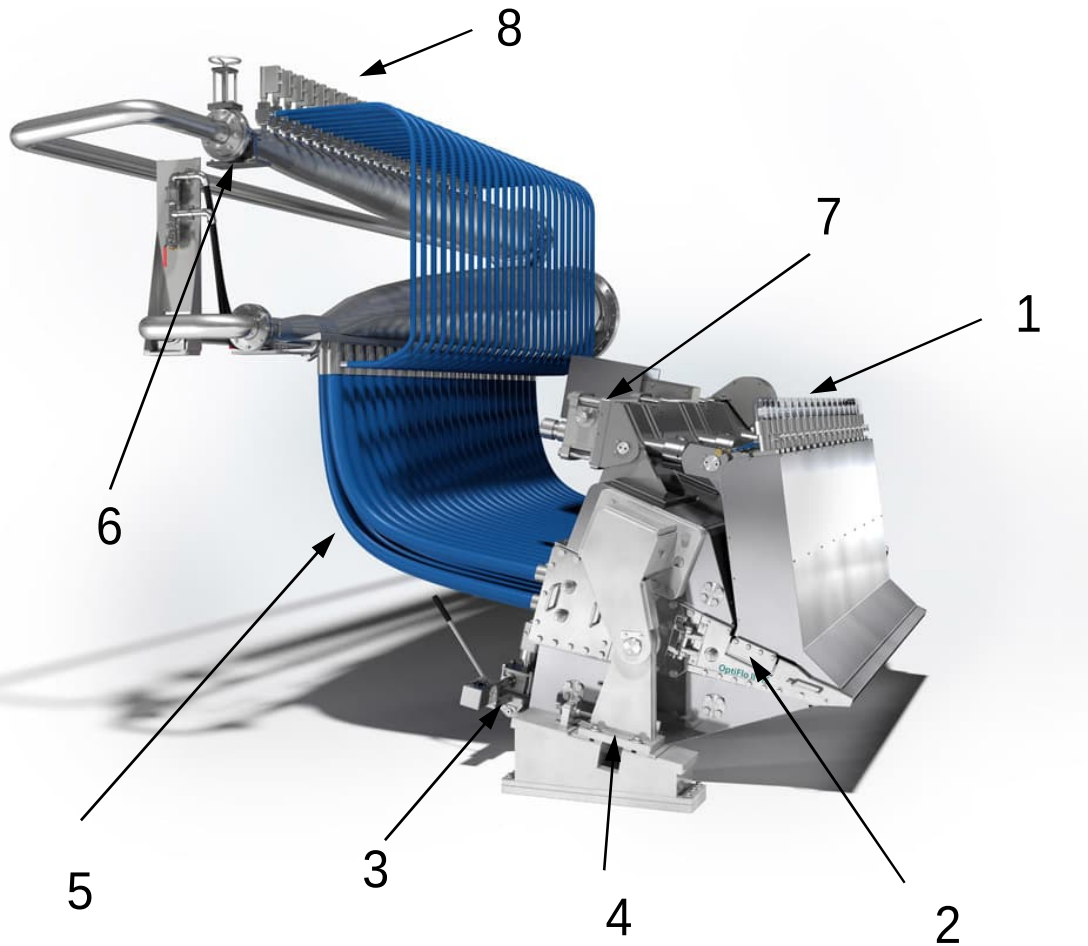


Principles of design

- Uniform basis weight profile
- Sheet formation
- Fiber orientation (MD/CD) uniformity
- Layering capability
- Stable jet geometry
- Clean design

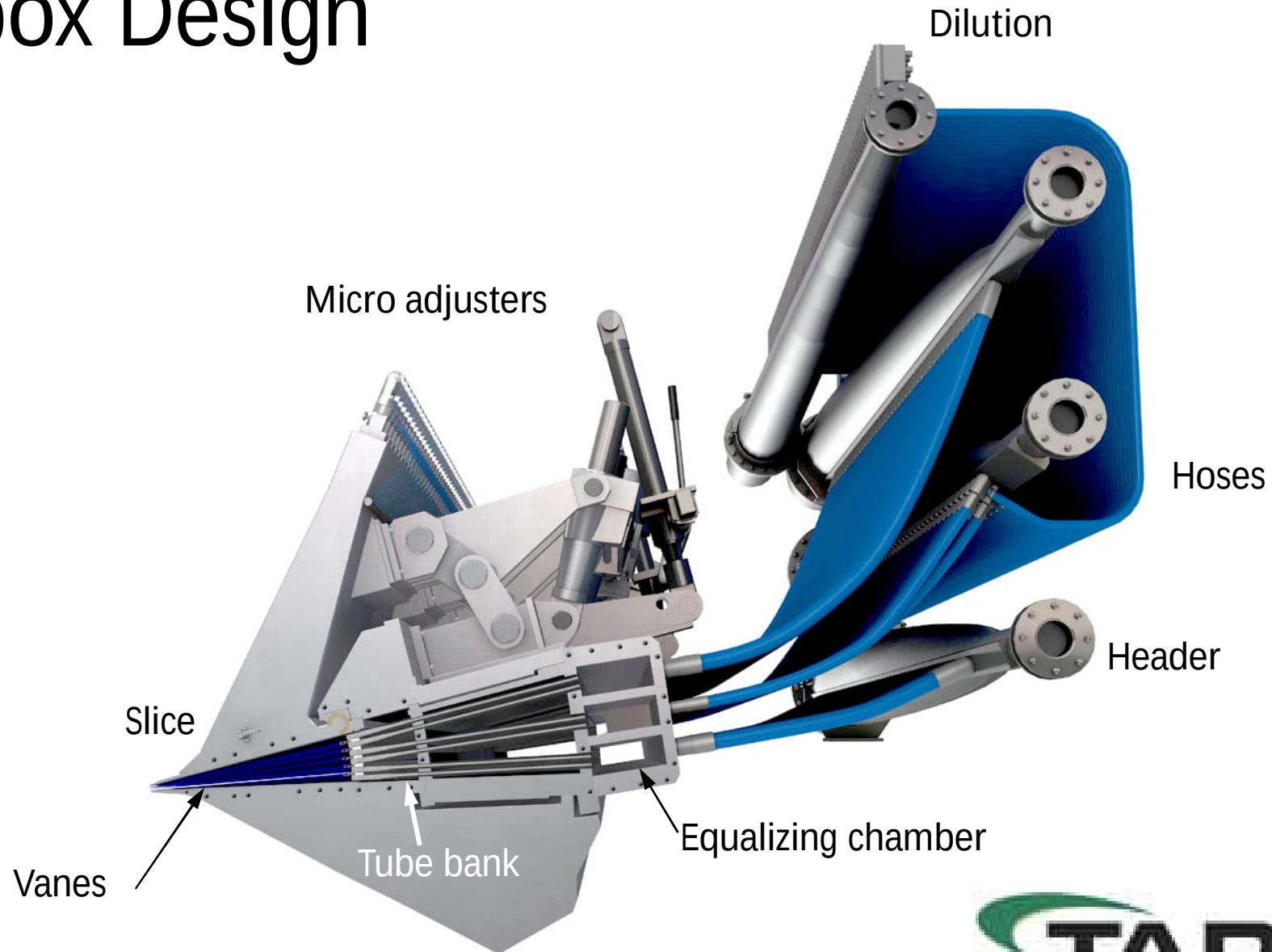


Tissue Headbox Feature

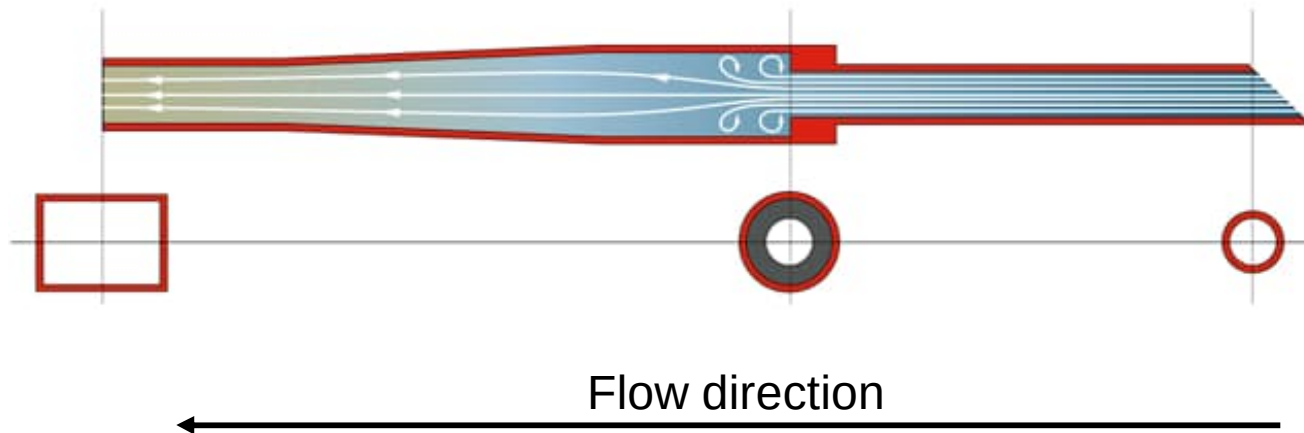
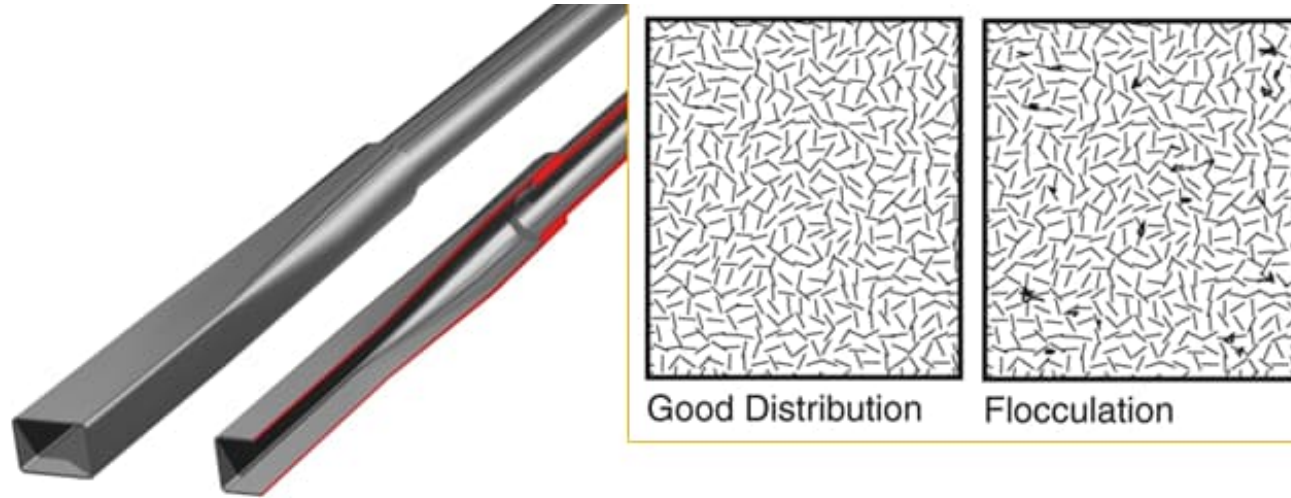


1. Micro adjusters
2. Hinged pond side doors enhance easy change of vanes, inspection and cleaning.
3. Screw jack enables adjusting the impingement angle during operation
4. Flexible mounting allows moving the Headbox laterally and vertically to facilitate easy fine –tuning of the position.
5. Long life flexible hoses connect the stand-alone headers to the Headbox optimum flexibility, which ease the adjustments of the Headbox position.
6. The header-balancing, adjusting the pressure balance in the header
7. Electrical screw jacks for remote control of the slice opening.
8. The dilution system automatically and continuously adjust basis weight profiling.

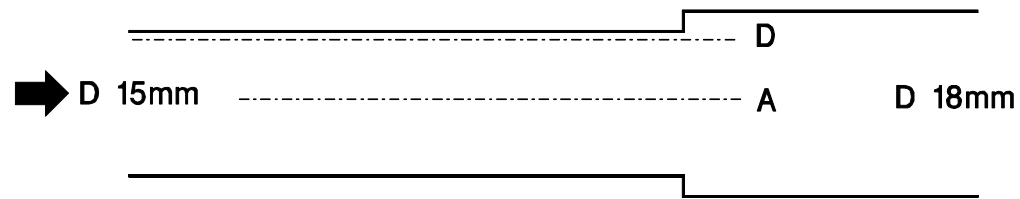
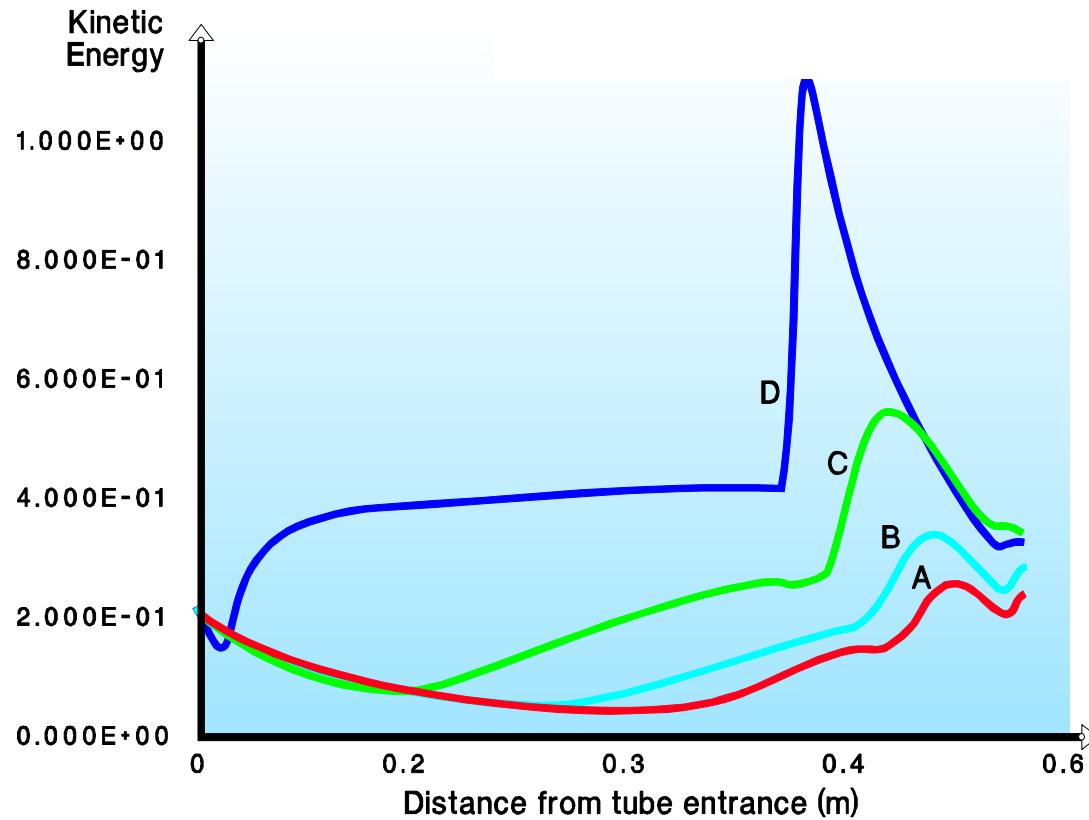
Headbox Design



Turbulence Tube

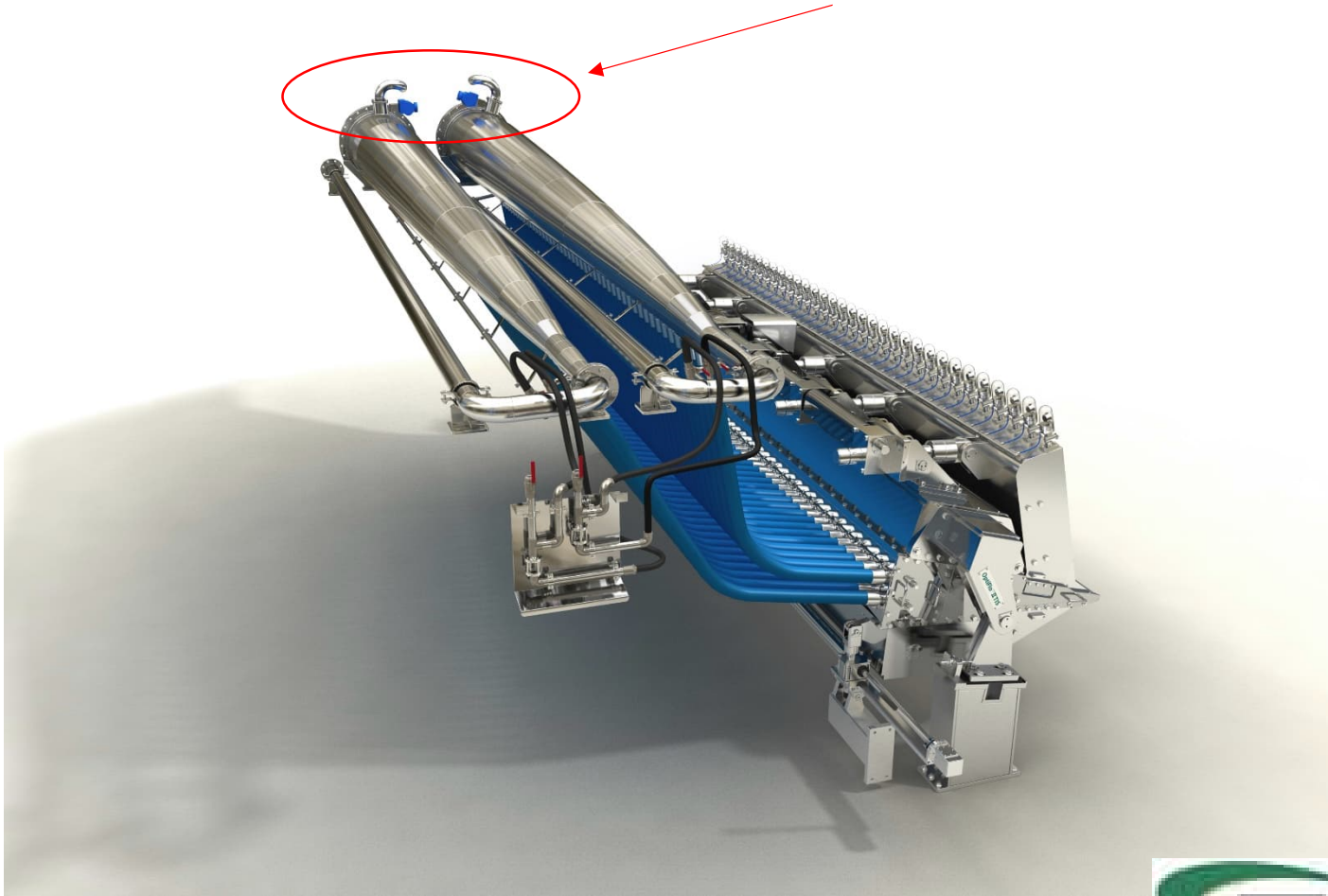


Kinetic Energy In Pipe With Expansion

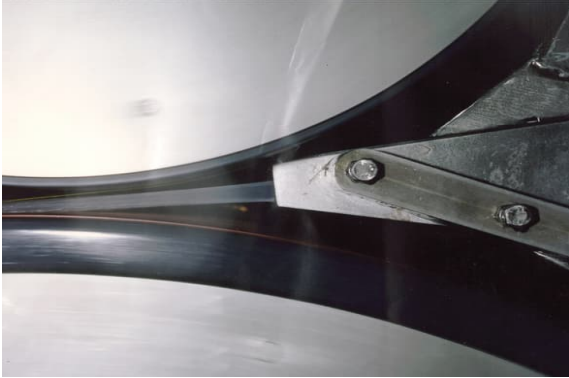


Headbox

Vacuum breaker valves



Typical Tissue Headbox data

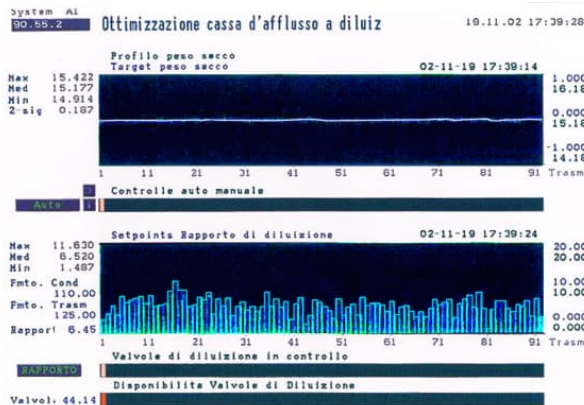


Slice opening

- DCT 10 -13 mm
- TAD 13 - 18 mm

Typical flow

- DCT 2000 m/min, slice lip 11 mm → 22.000 l/min/m
- TAD 1800 m/min, slice lip 15 mm → 27.000 l/min/m



Typical fiber concentration in HBX

- 0.1 -0.4%

Basis weight variation (TAPPI 545)

- Peak to peak +/- 1.5 – 3% (with dilution 0.5 - 1.5)

Useful calculation formulas for HBX

- Pressure Head box = $\rho * (\text{Jet speed}/60)^2 / 2$
 - Where : P = Pa, Jet speed = m/min, ρ = kg/m³
- HBX flow = $\text{Jet speed} * (\text{BW} + \text{FCB}) * 10 / (C_{\text{HBX}} * \text{FPR})$
 - Where HBX flow = l/min, BW = g/m², FCB = g/m², C_{HBX} = %, FPR = %
- $\text{FPR} = (C_{\text{HBX}} - C_{\text{w/w}}) / C_{\text{HBX}} * 100$

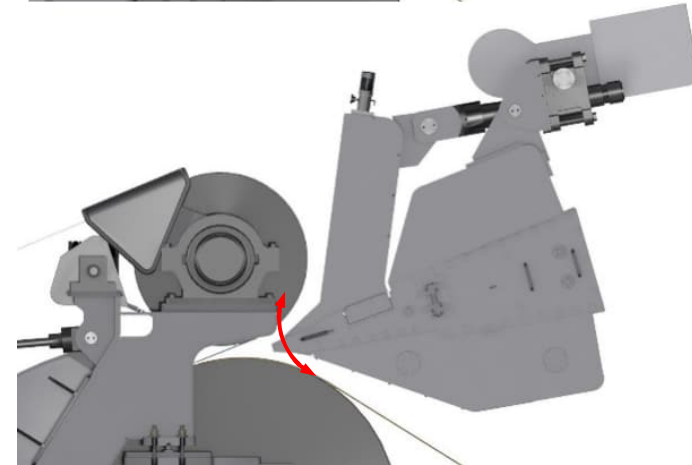
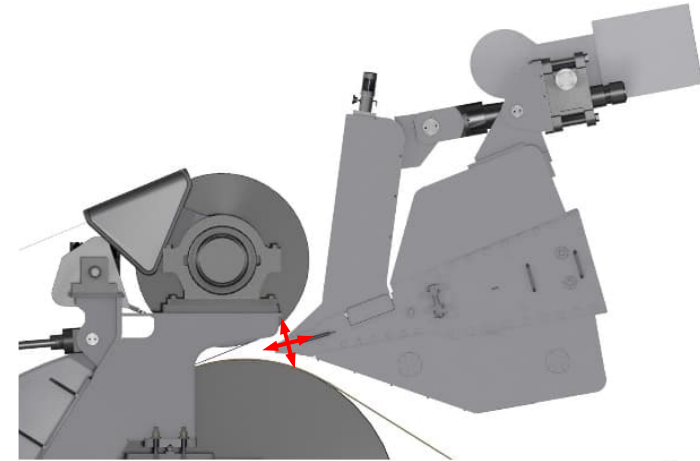
Tissue Headbox

Control & Optimization

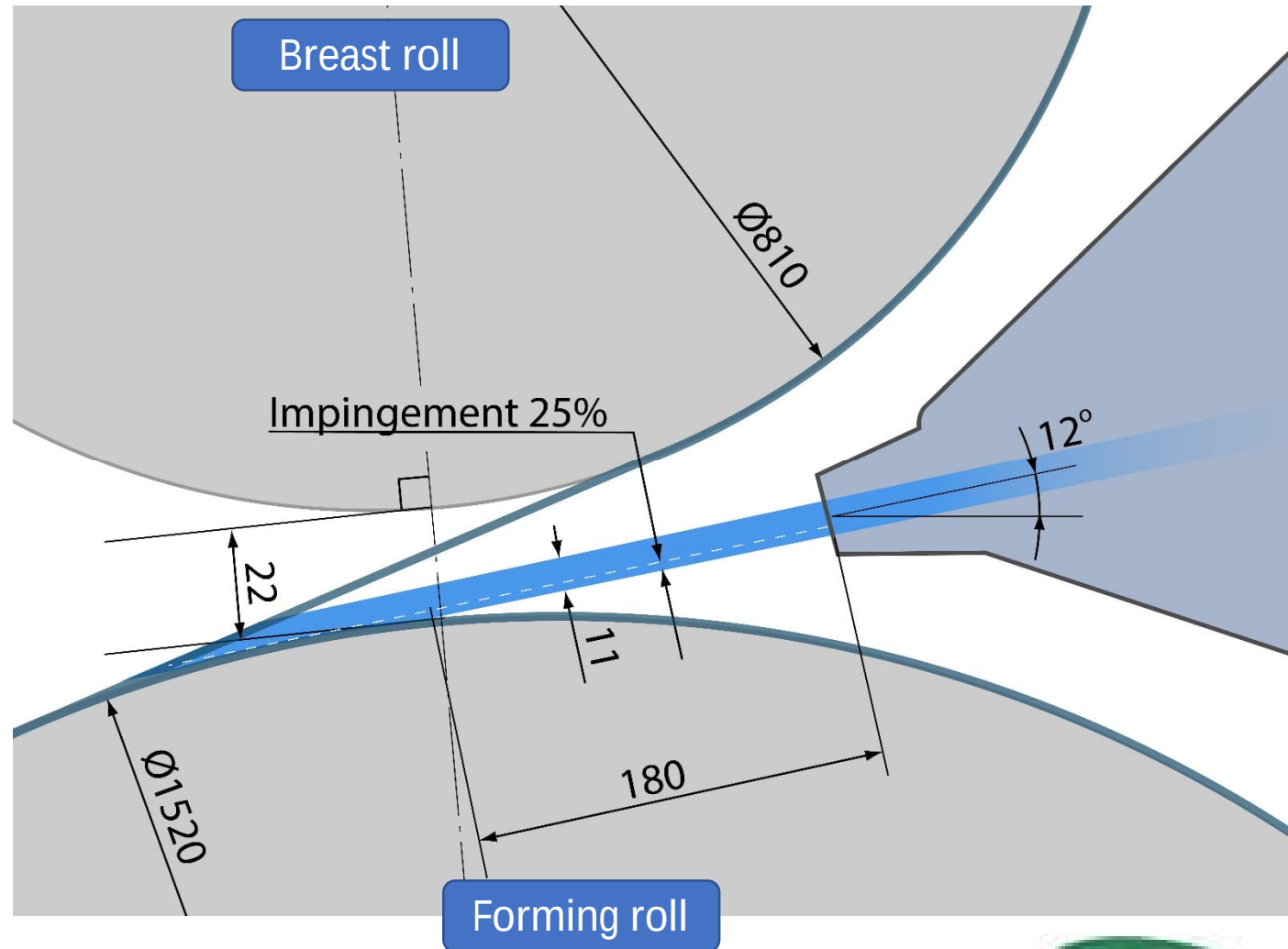


Jet geometry

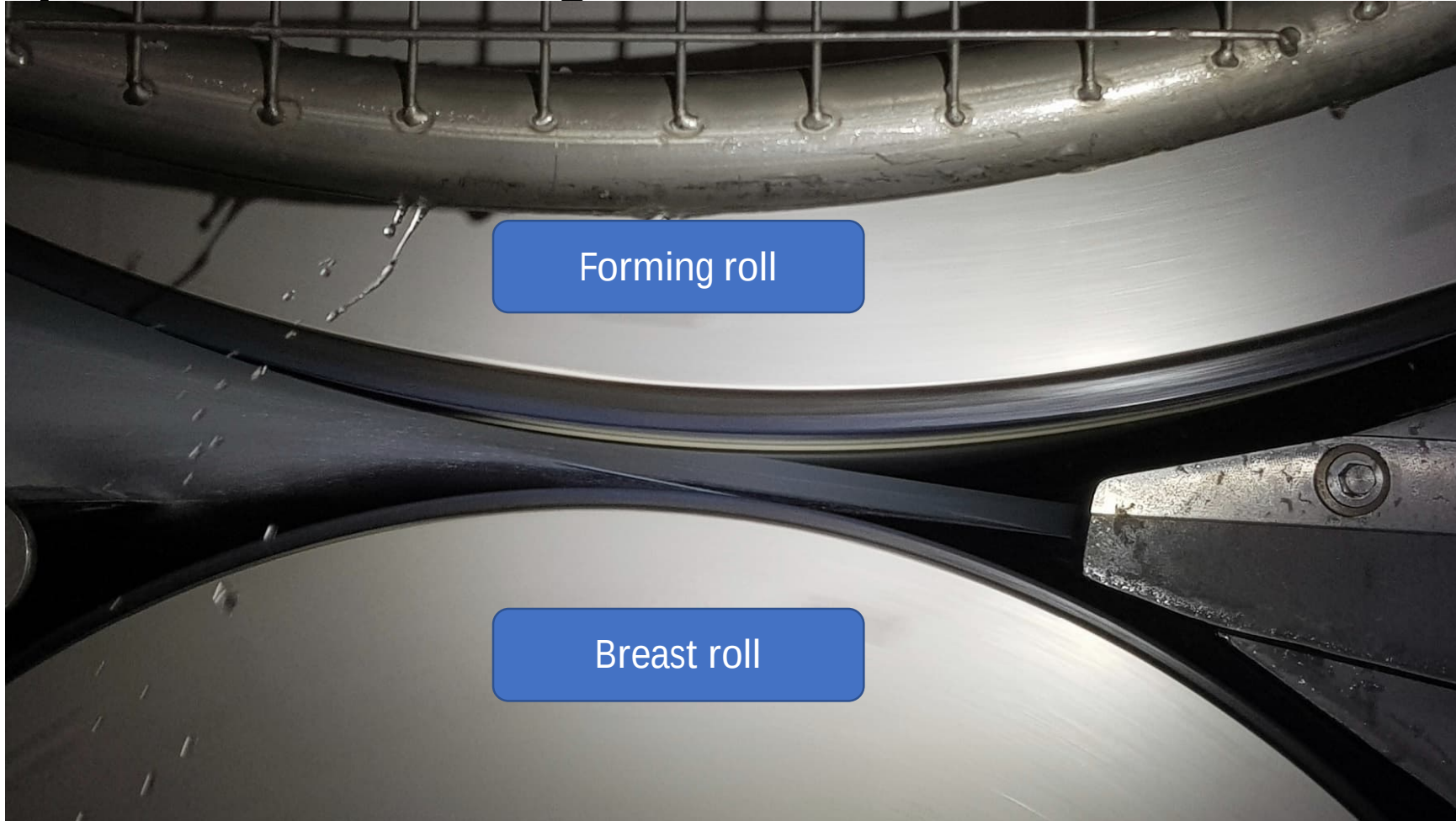
- Impingement,
% of jet that impinges on the forming roll
- Jet length,
distance between slice lip and centerline of
the forming roll-breast roll
- Jet angle,
angle between jet and horizontal line
- Gap,
distance between forming roll and breast roll



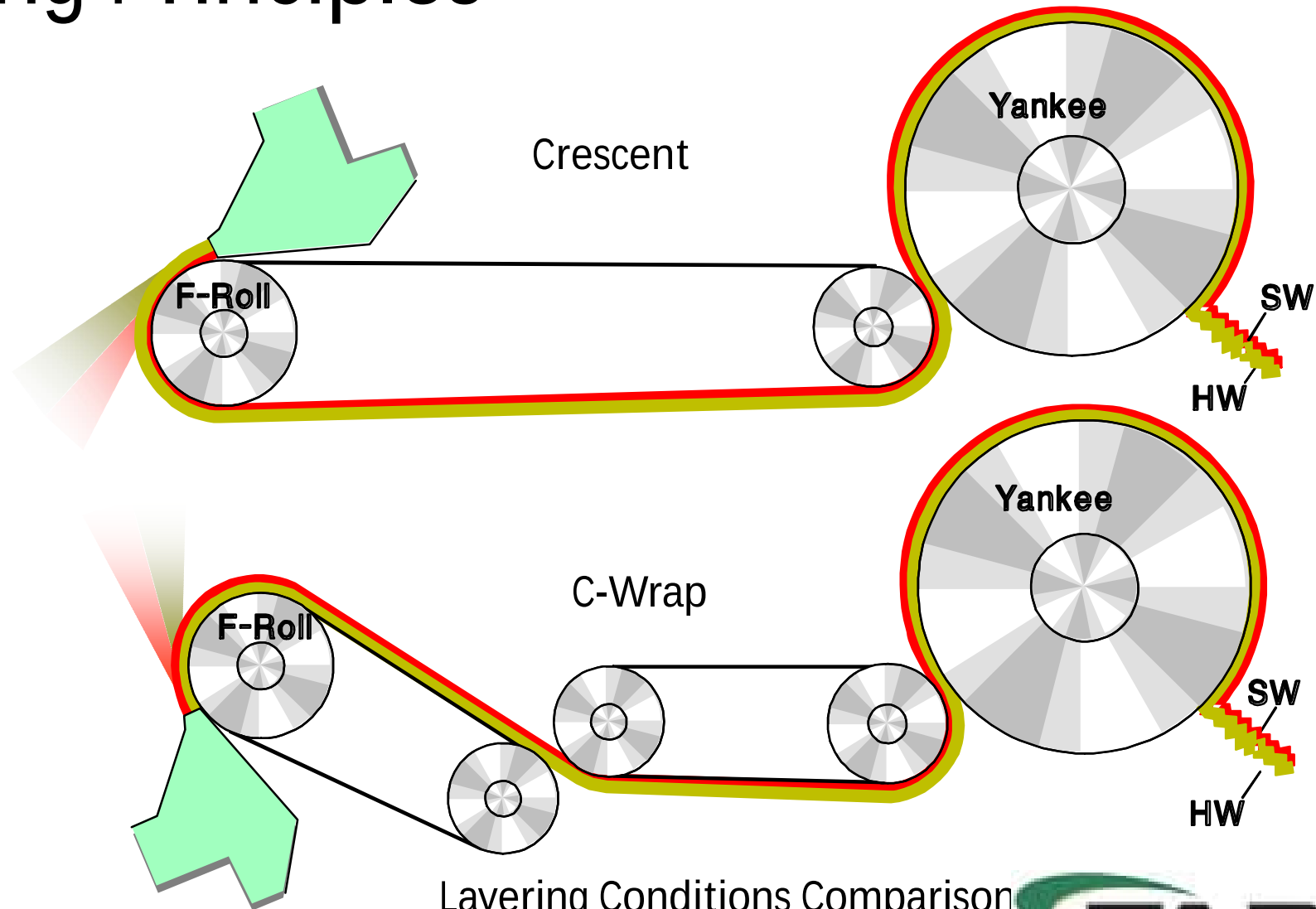
Initial setup



Example : Advantage NTT



Forming Principles

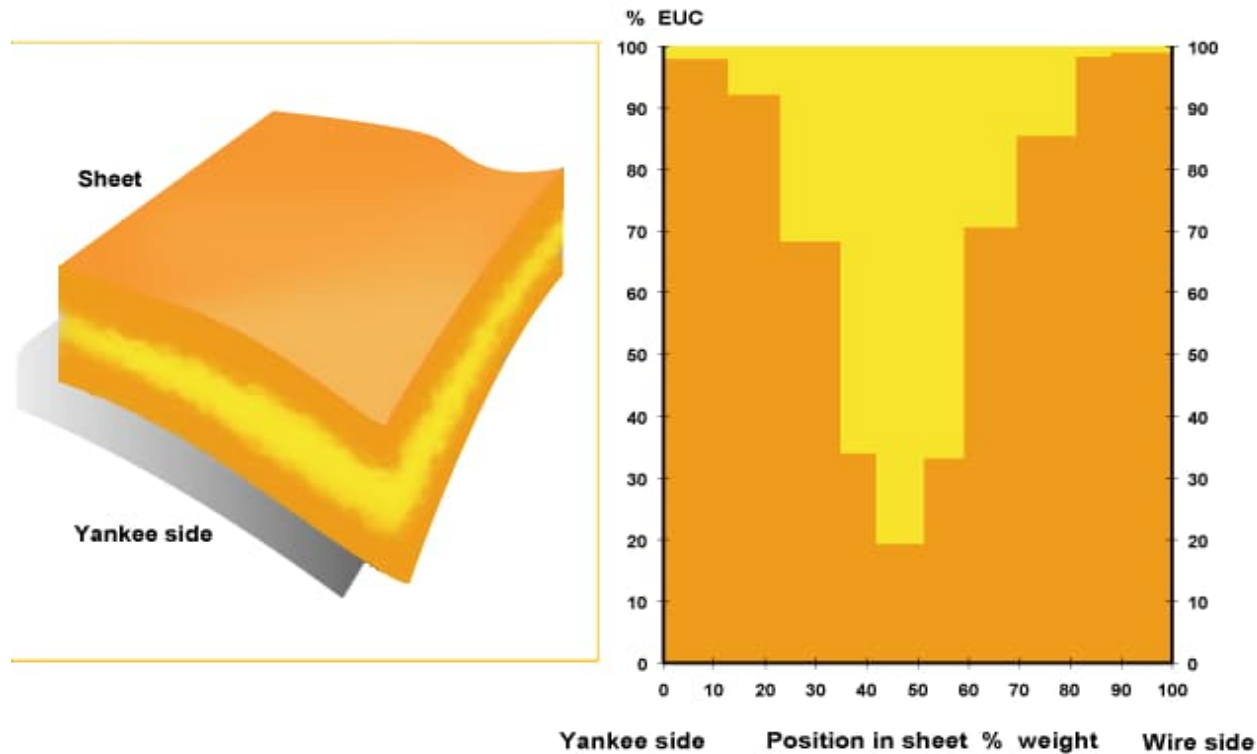


Layering Conditions Comparison

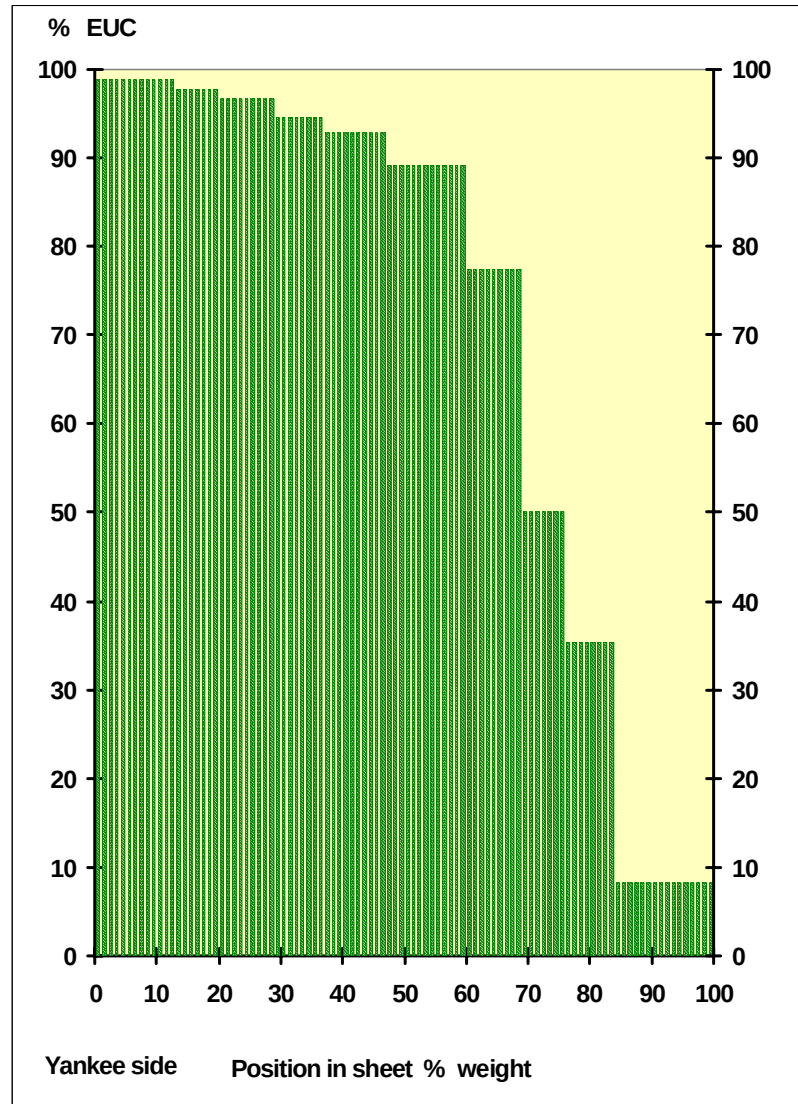
Triple layers product

Basis weight: 27,0 g / m²
Machine speed: 1 200 m / min
Weight factor for: EUC = 0,40 SW = 0,90

This 3 layer contains 71,8 % EUC
28,2 % SW

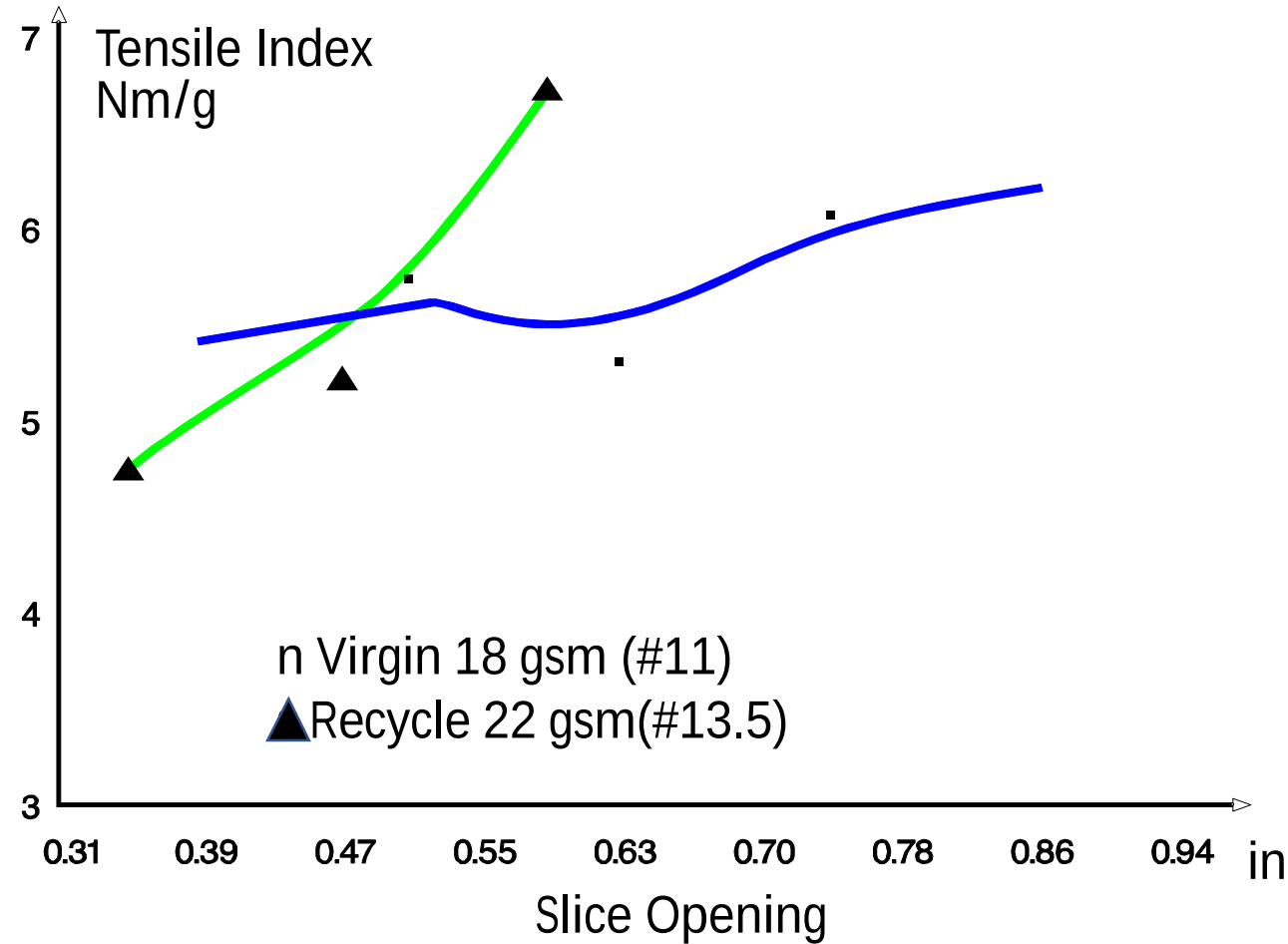


Double layers product

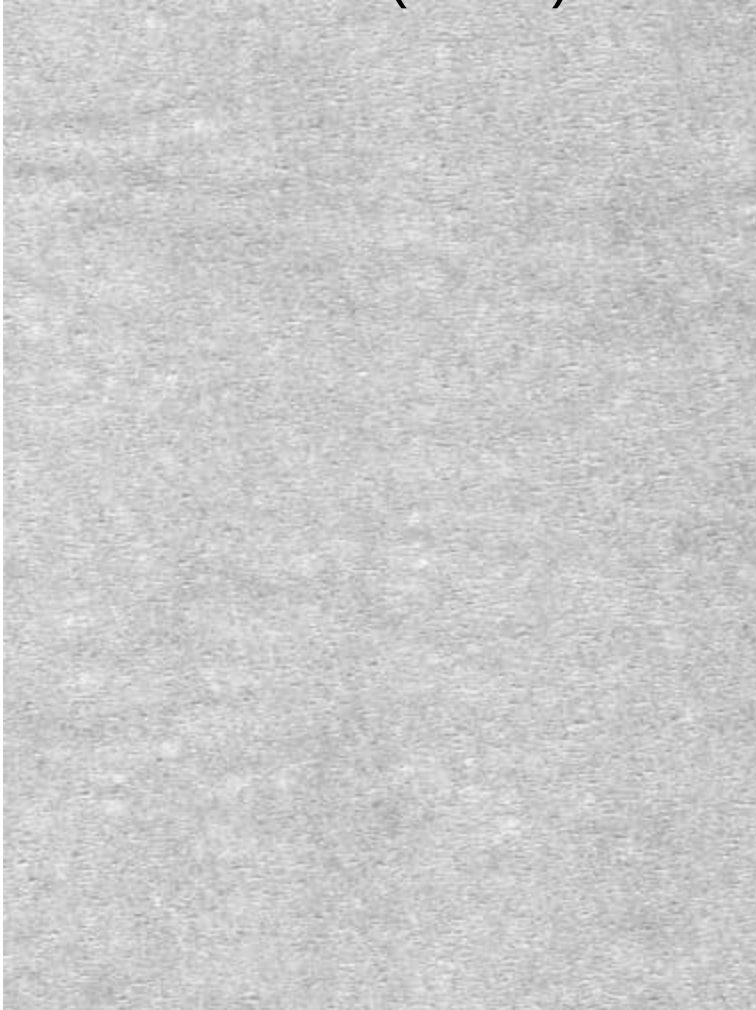


Bathroom tissue 16 g/m²
70% HW / 30% SW

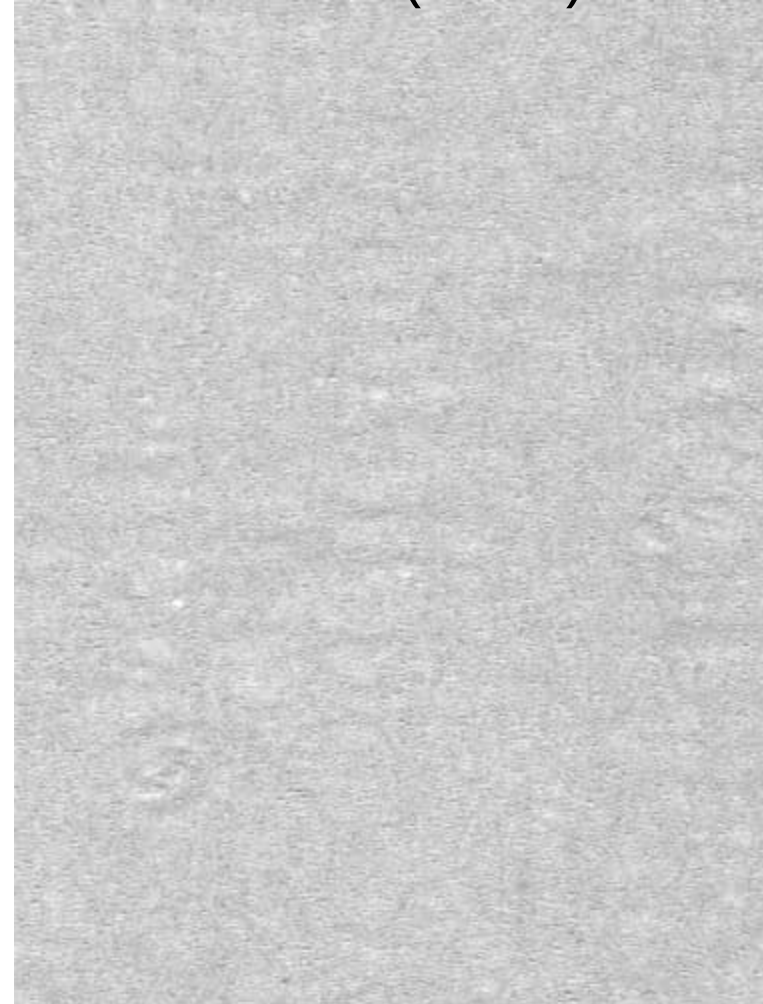
Tensile Index vs Slice Opening



Slice Opening:
11 mm (0.43")

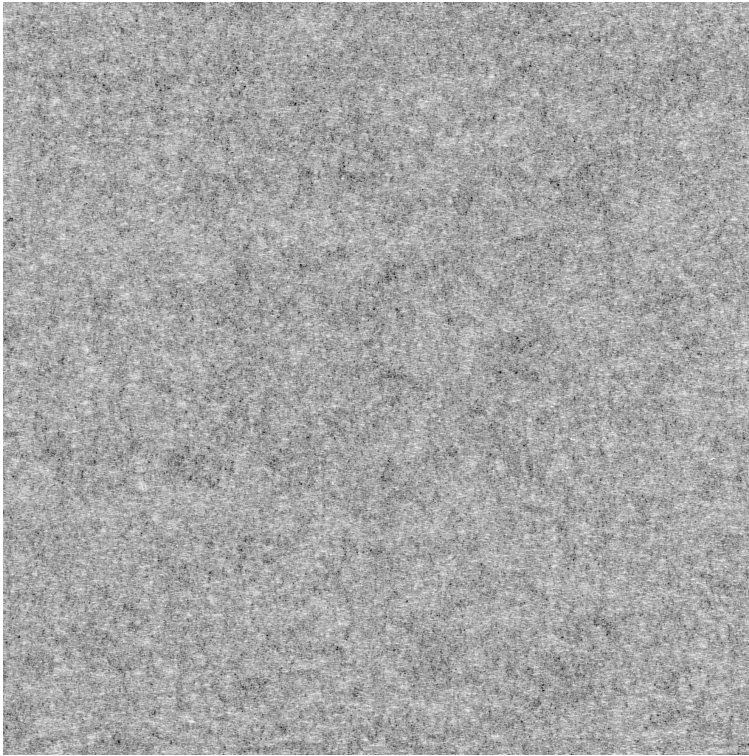


Slice opening:
15 mm (0.59")



Increase Hardwood

Case Study: Formation Improvement

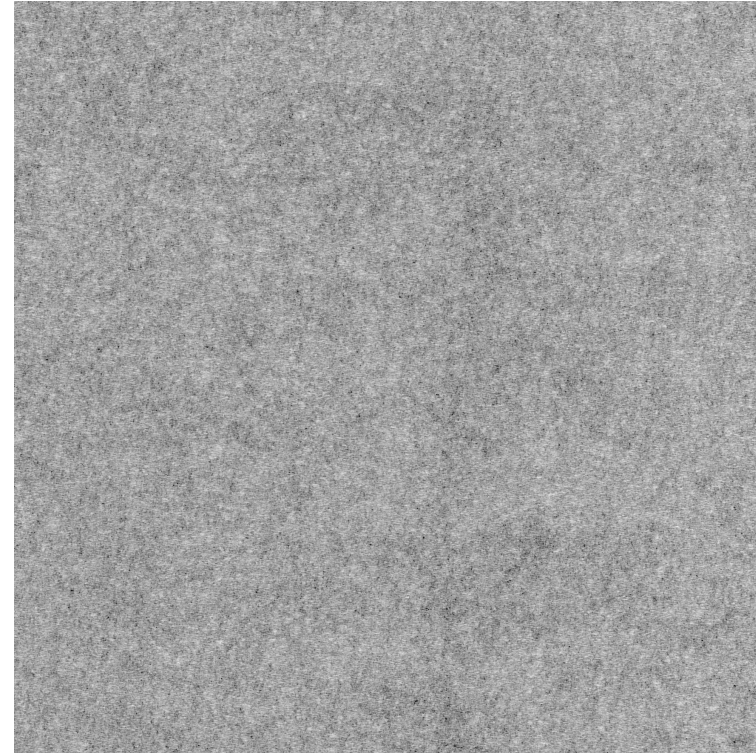


Ref. 1

$SW_{HL}/HW_{YL}=50/50\%$

$HB_{conc.HL}=0.181\%$

$HB_{conc.YL}=0.181\%$



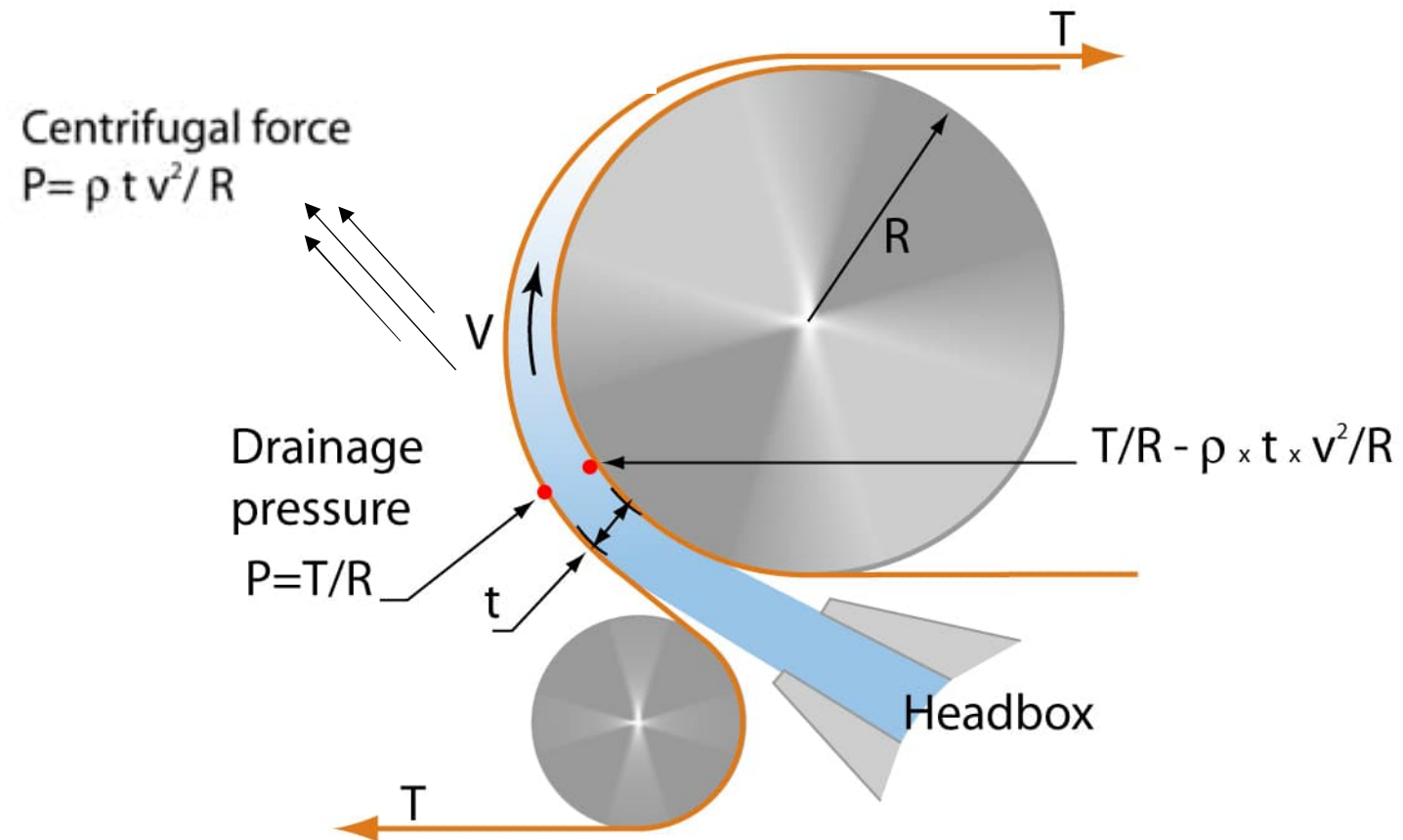
Trial. 6

HW share = 62.5%

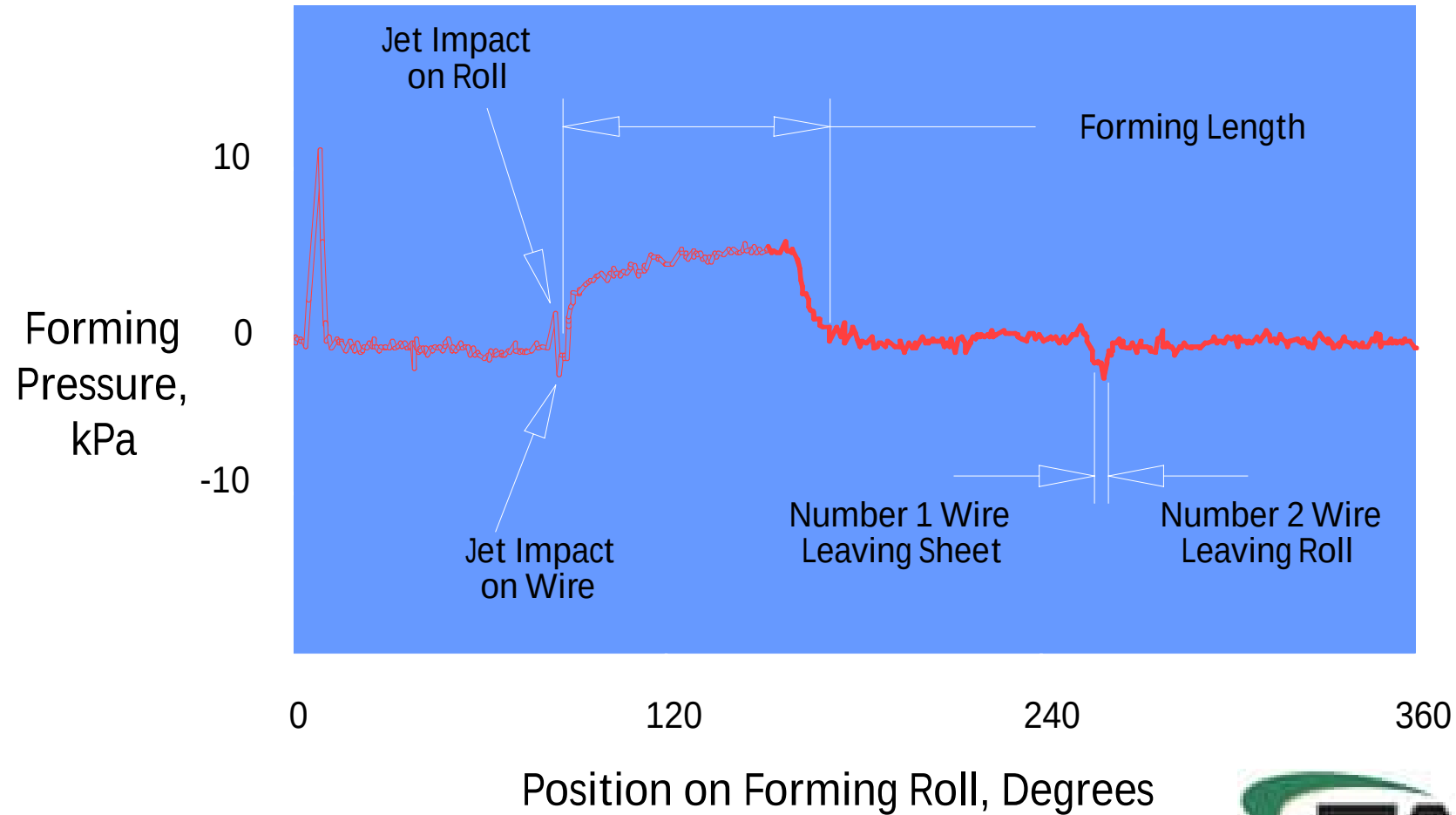
$HB_{conc.HL}=0.181\%$, $37.5_{SW}/12.5_{HW}\%$

$HB_{conc.YL}=0.181\%$, $50_{HW}\%$

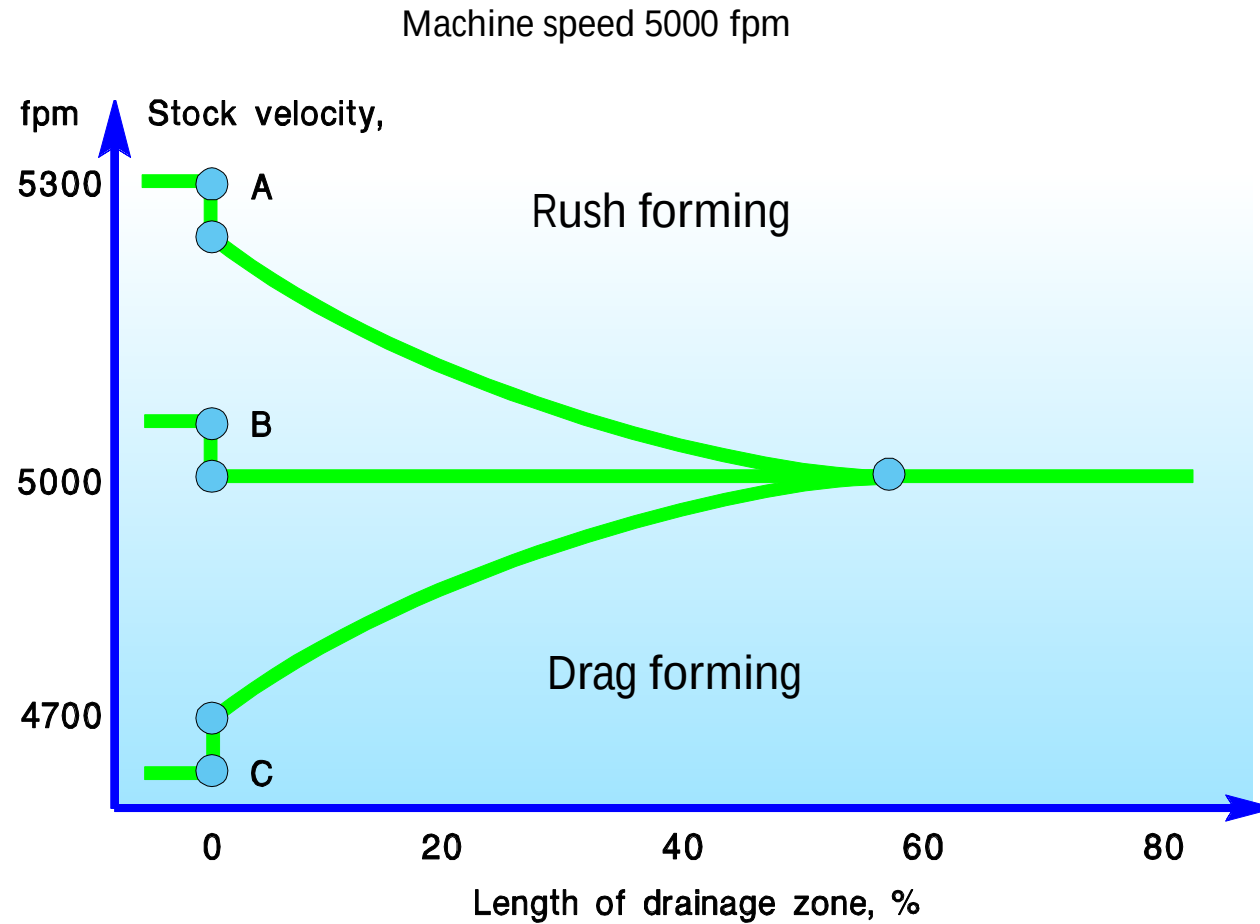
Drainage pressure



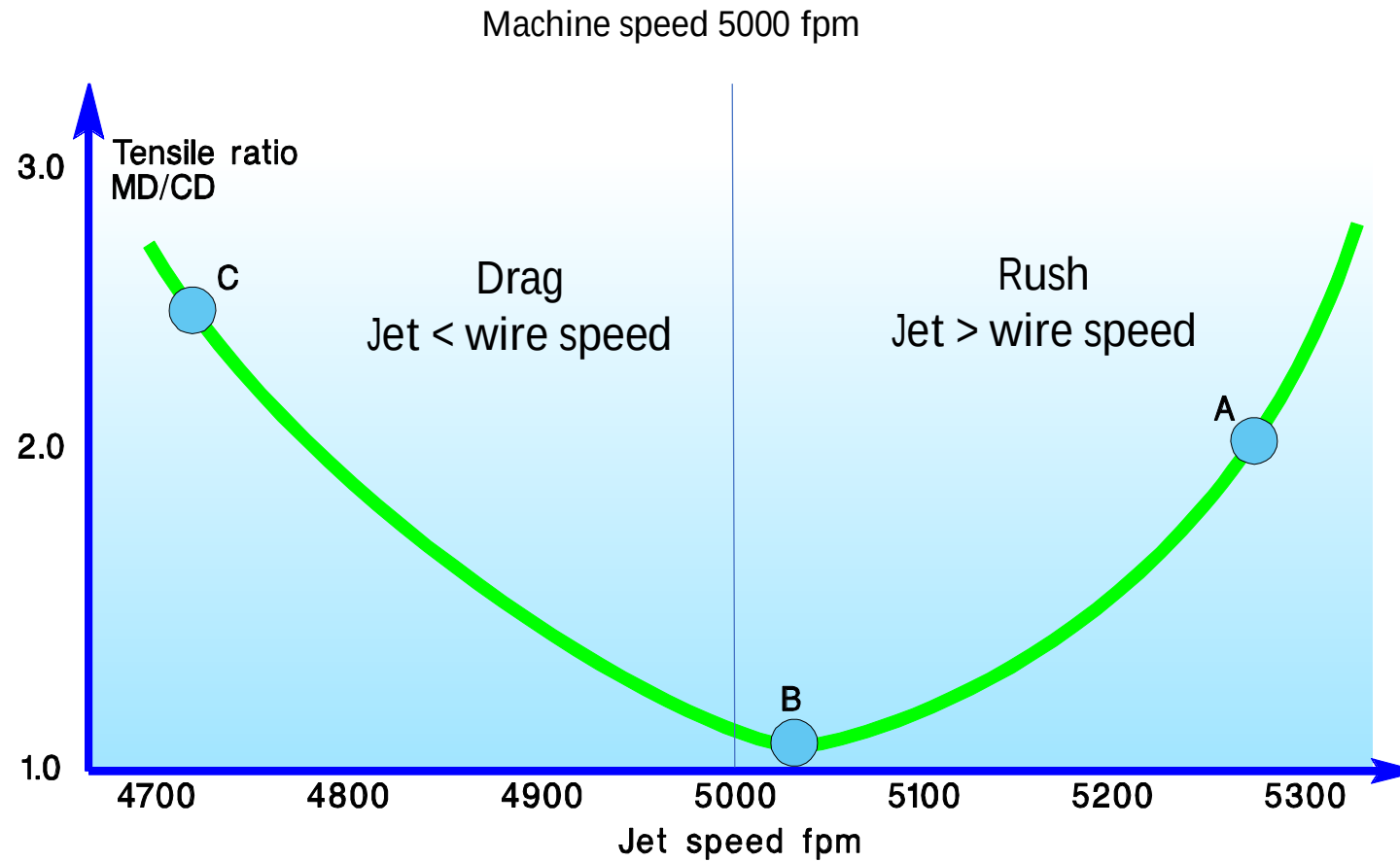
Drainage Pressure Profile Through Forming Zone



Stock Velocity During Drainage

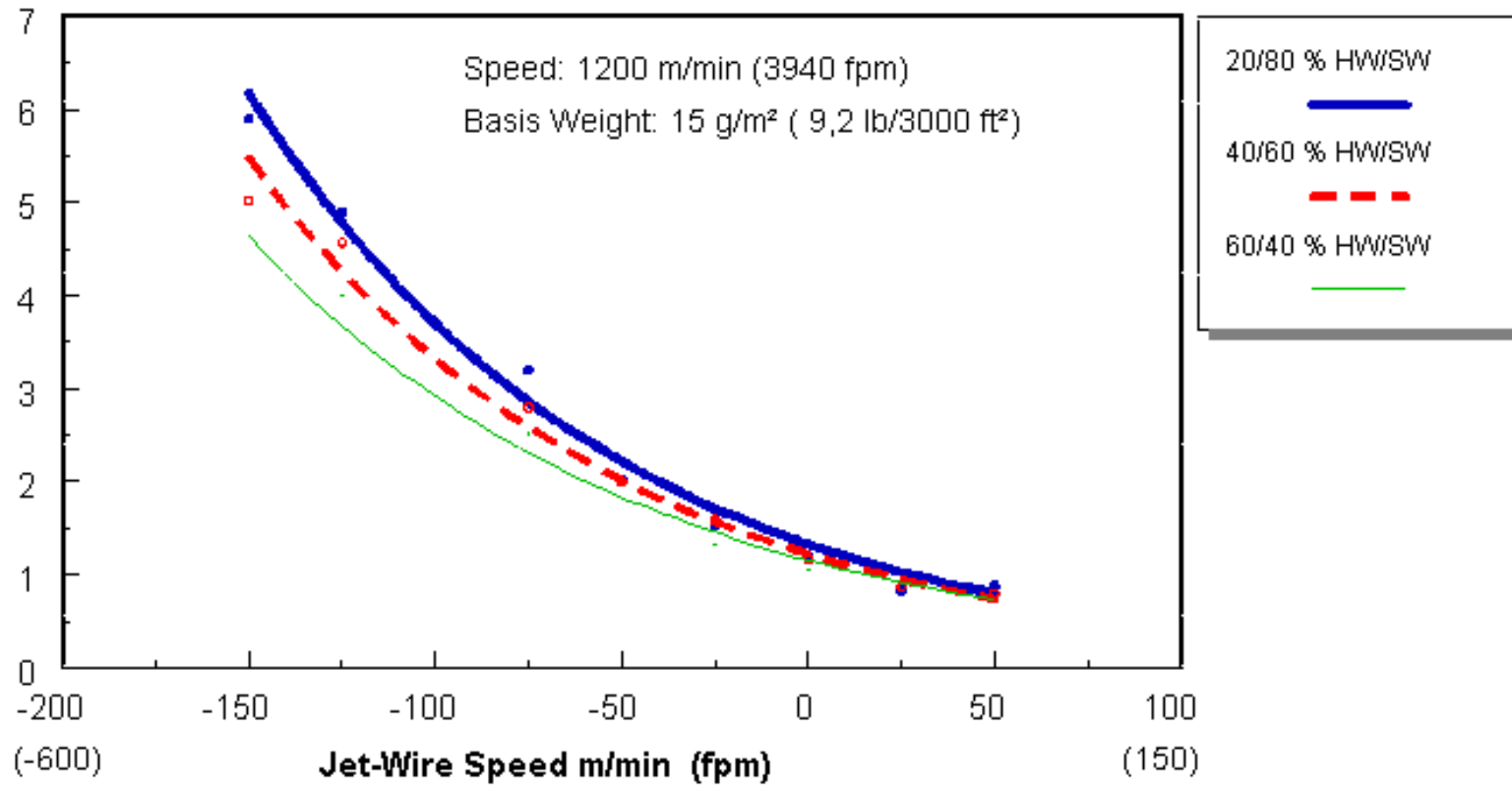


Tensile Ratio vs Jet Speed



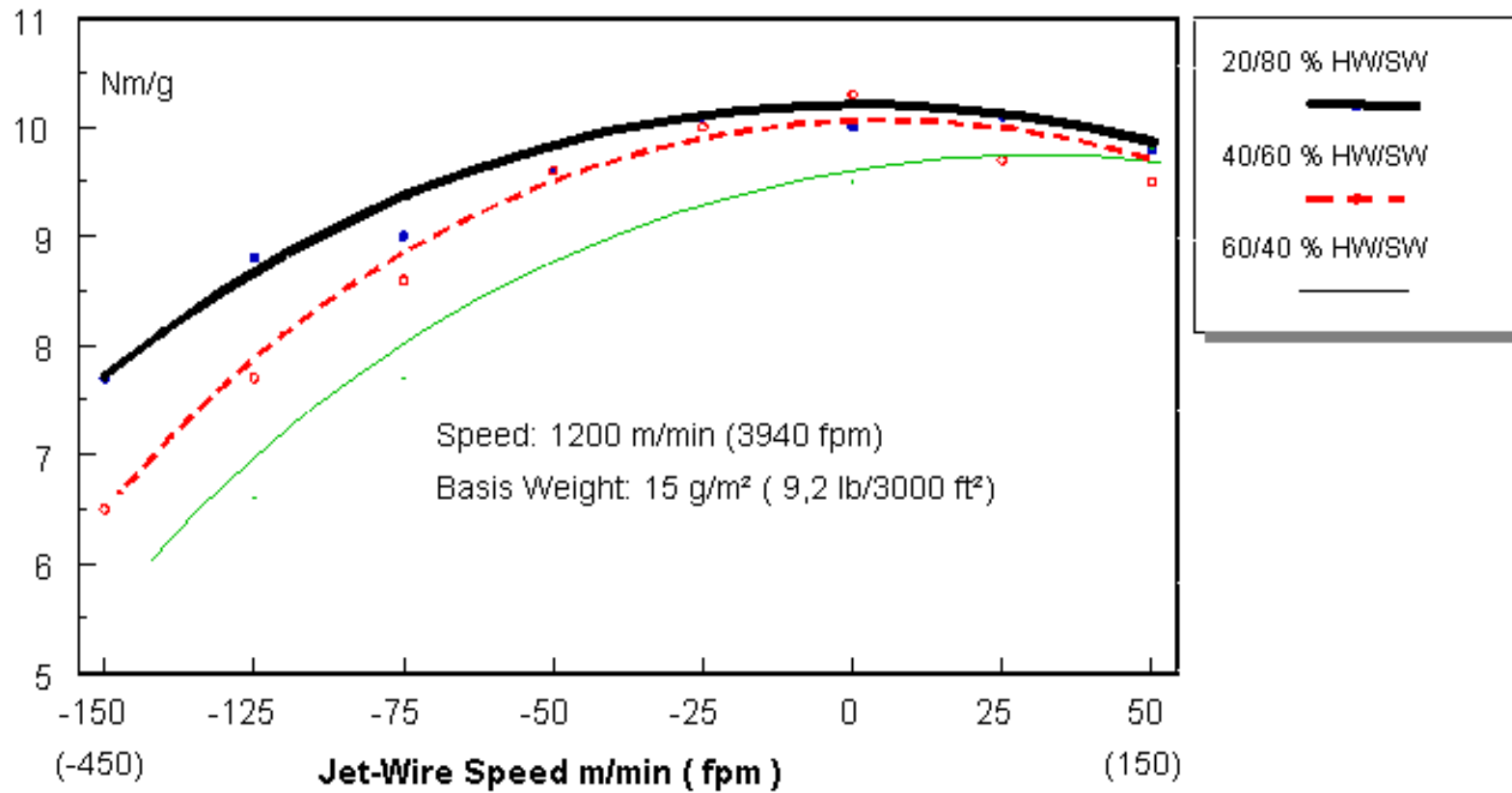
Tensile Ratio Curve

Tensile Ratio MD/CD

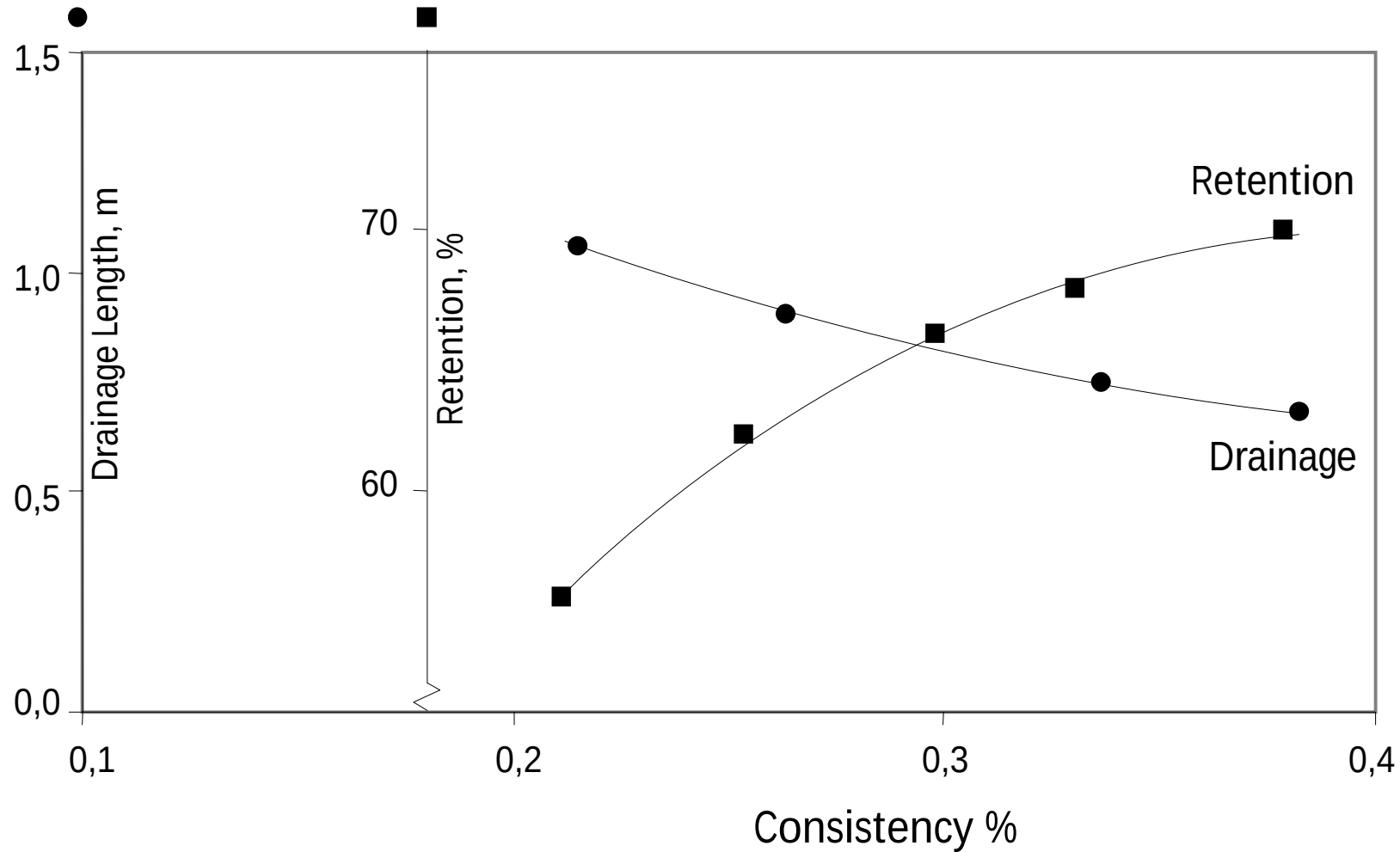


Total Tensile

Geometrical tensile index $(MD \cdot CD)^{1/2} / BW$

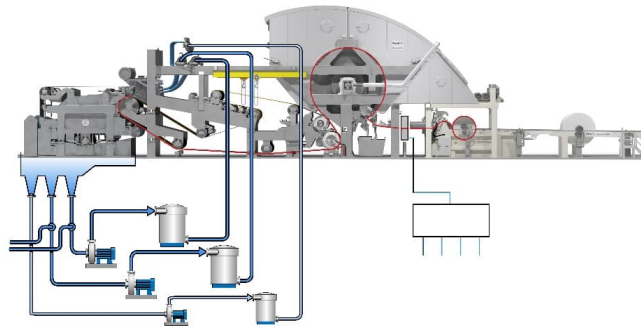
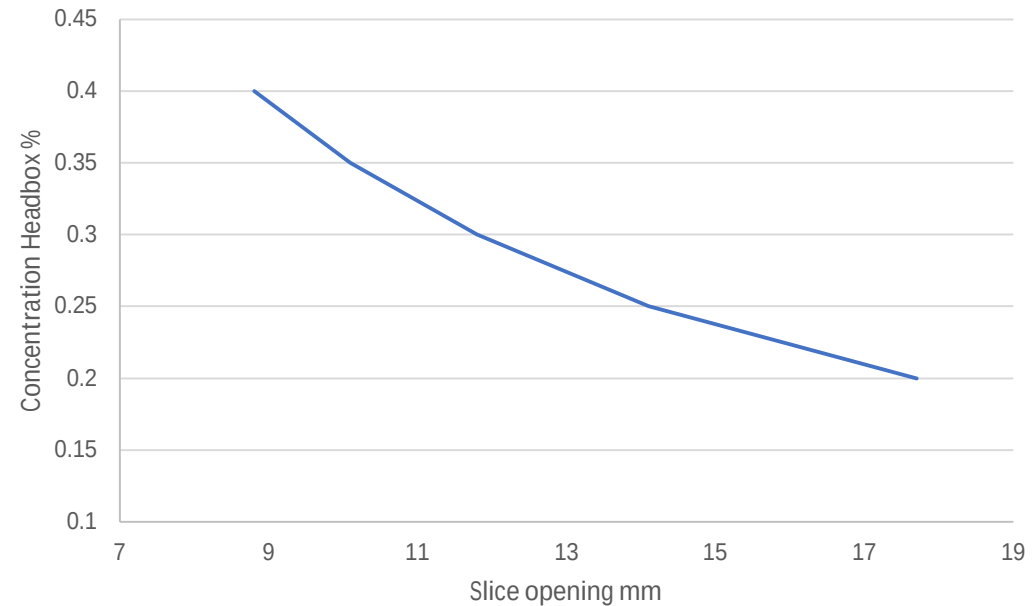


Drainage and Retention vs Consistency



Headbox Control Conc. vs Slice opening

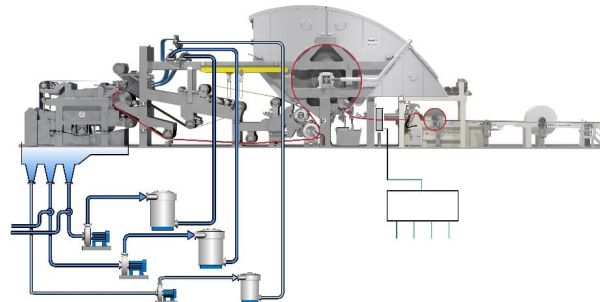
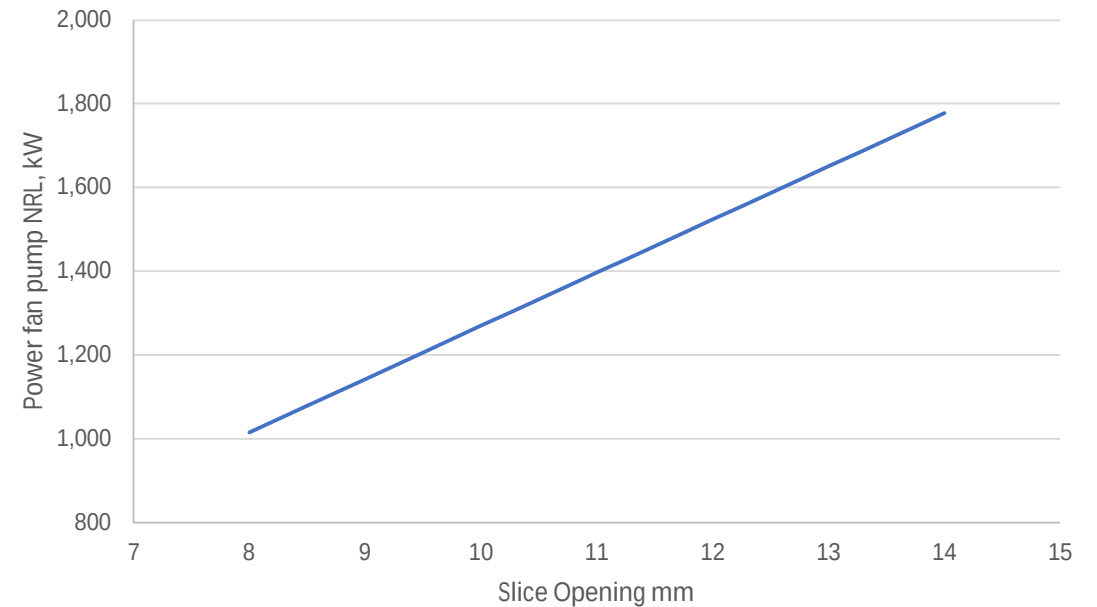
- Basis weight wire 20 g/m²
- Machine speed 1800 m/min
- Jet speed 1750 m/min
- Slice opening **varying** mm
- Conc. Headbox **varying** %
- Fiber carry back 0,6 g/m²
- First pass retention 60%
- Headbox width 5706 mm
- Required pressure at fan pump 700 kPa



Headbox Control

Slice opening vs Energy consumption

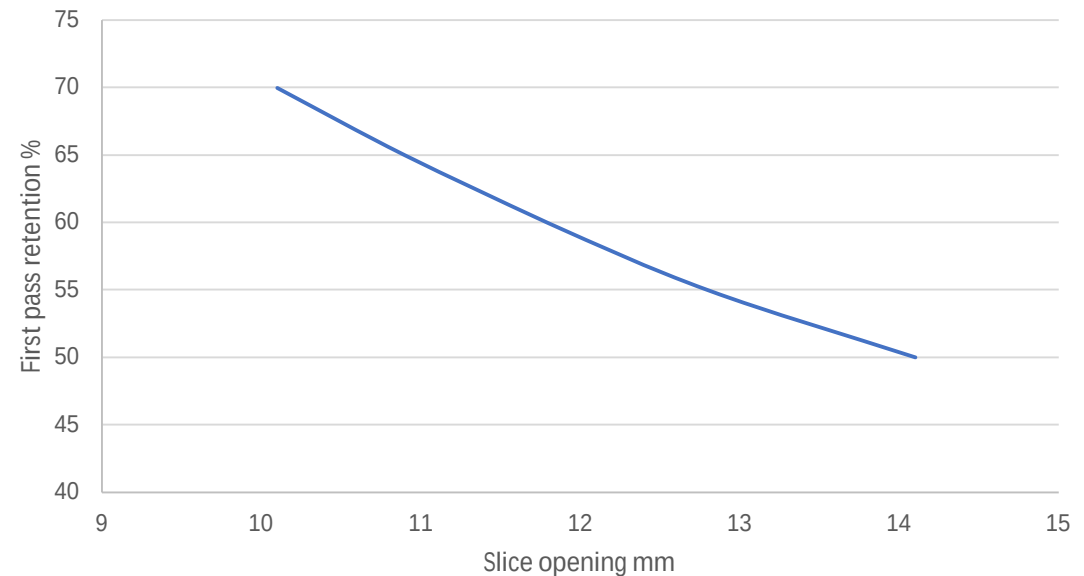
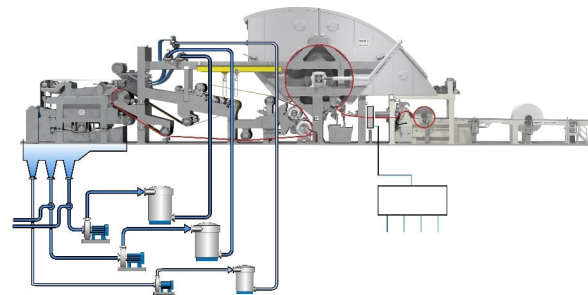
- Basis weight wire 20 g/m²
- Machine speed 1800 m/min
- Jet speed 1750 m/min
- Slice opening **varying** mm
- Conc. Headbox 0,3 %
- Fiber carry back 0,6 g/m²
- Headbox width 5706 mm
- Required pressure at fan pump 700 kPa



Headbox Control

First pass retention vs Slice opening

- Basis weight wire 20 g/m²
- Machine speed 1800 m/min
- Jet speed 1750 m/min
- Slice opening **varying** mm
- Conc. Headbox 0,3 %
- Fiber carry back 0,6 g/m²
- First pass retention **varying** %
- Headbox width 5706 mm
- Required pressure at fan pump 700 kPa



Extra vigilance on HBX setting and consistency when compare two different machines together .

Basis weight profiling

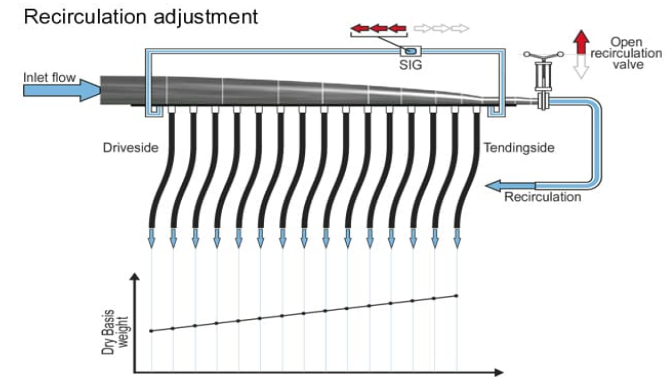
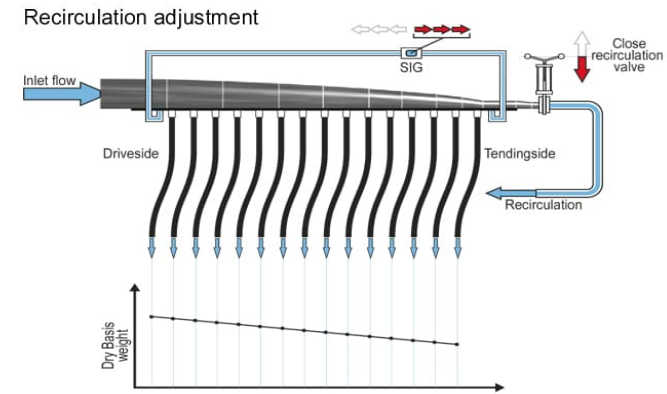
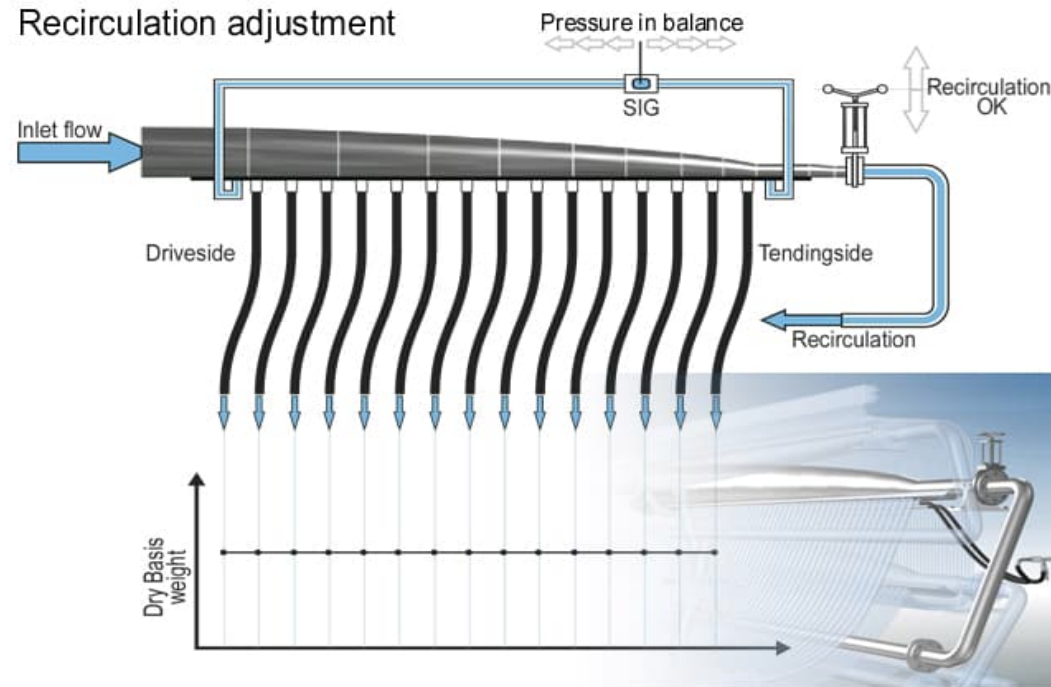
Recirculation

Microadjuster

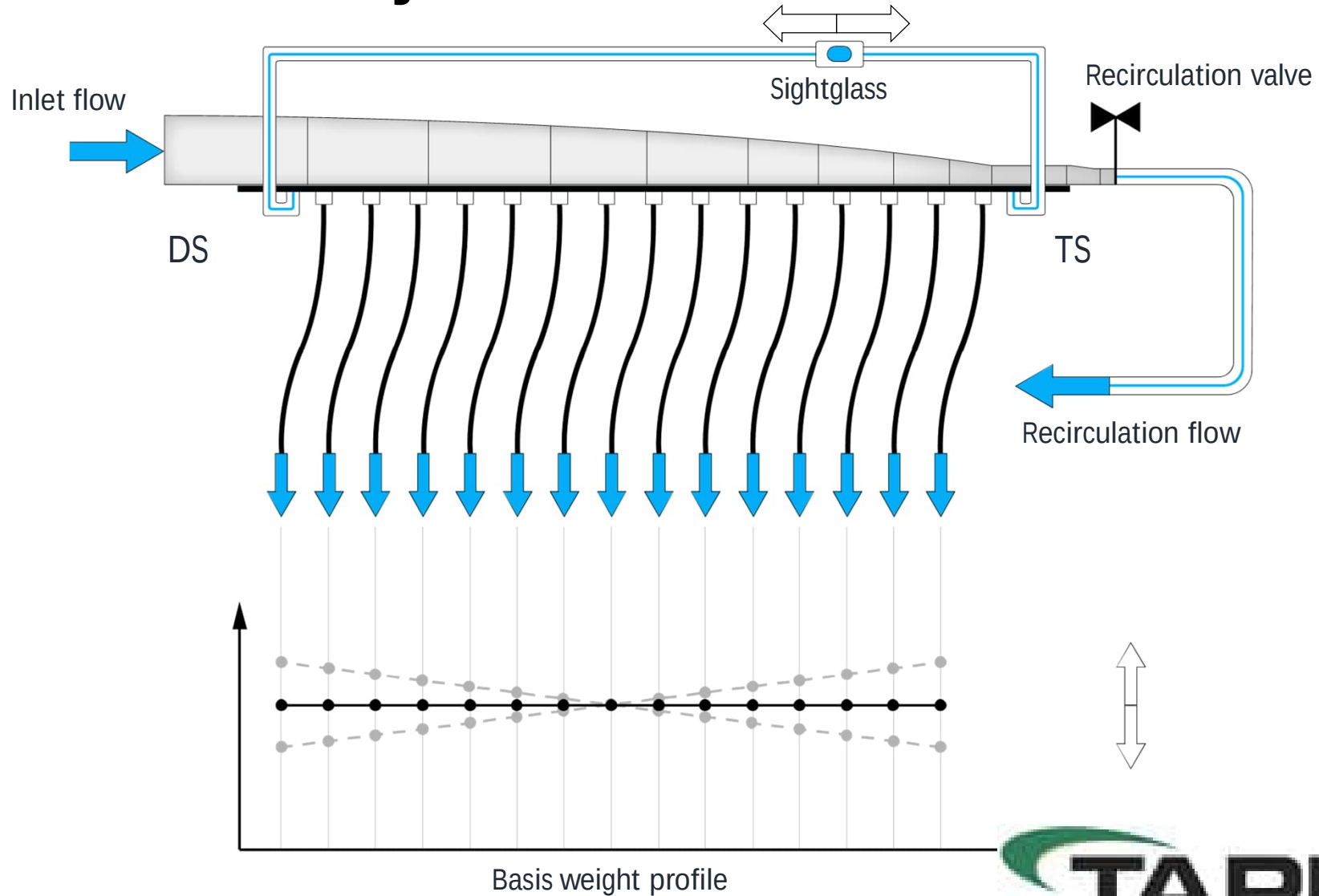
Dilution Control



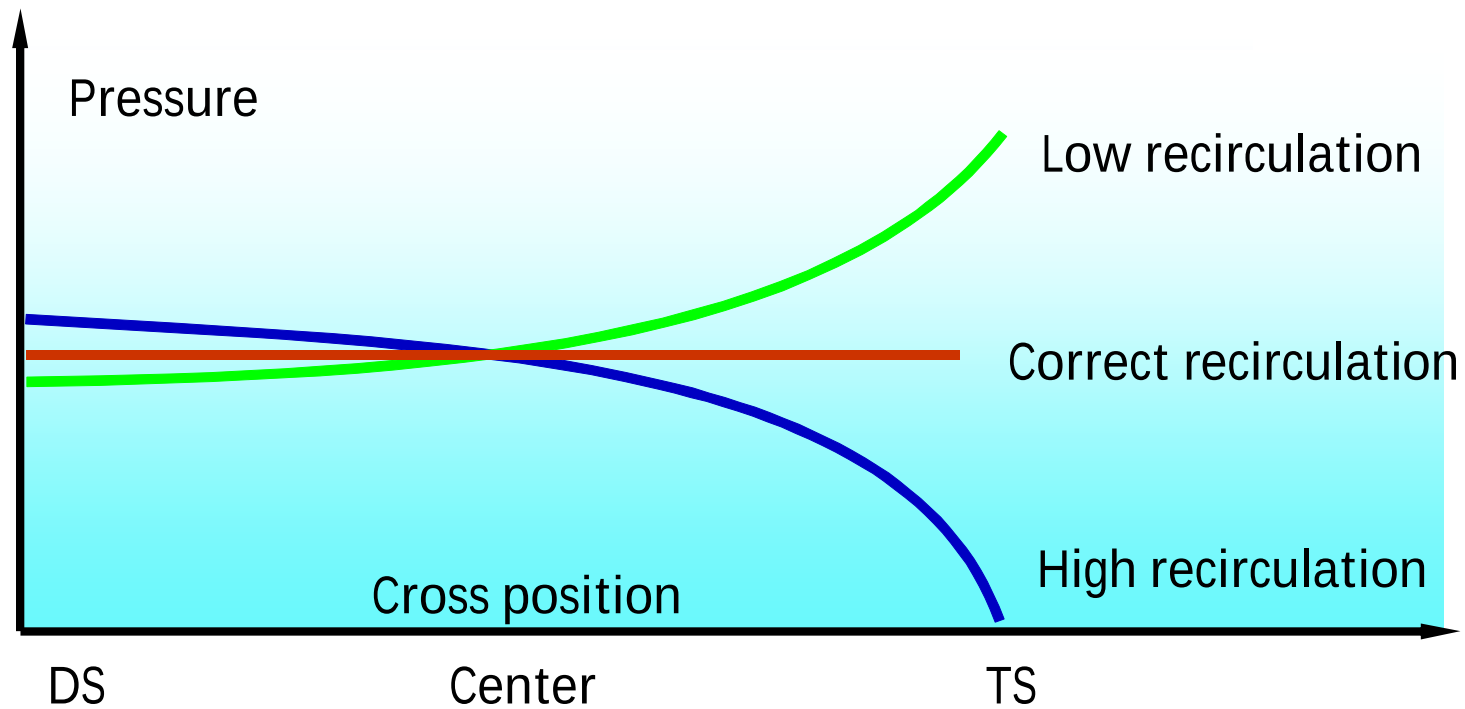
Recirculation adjustment



Recirculation adjustment



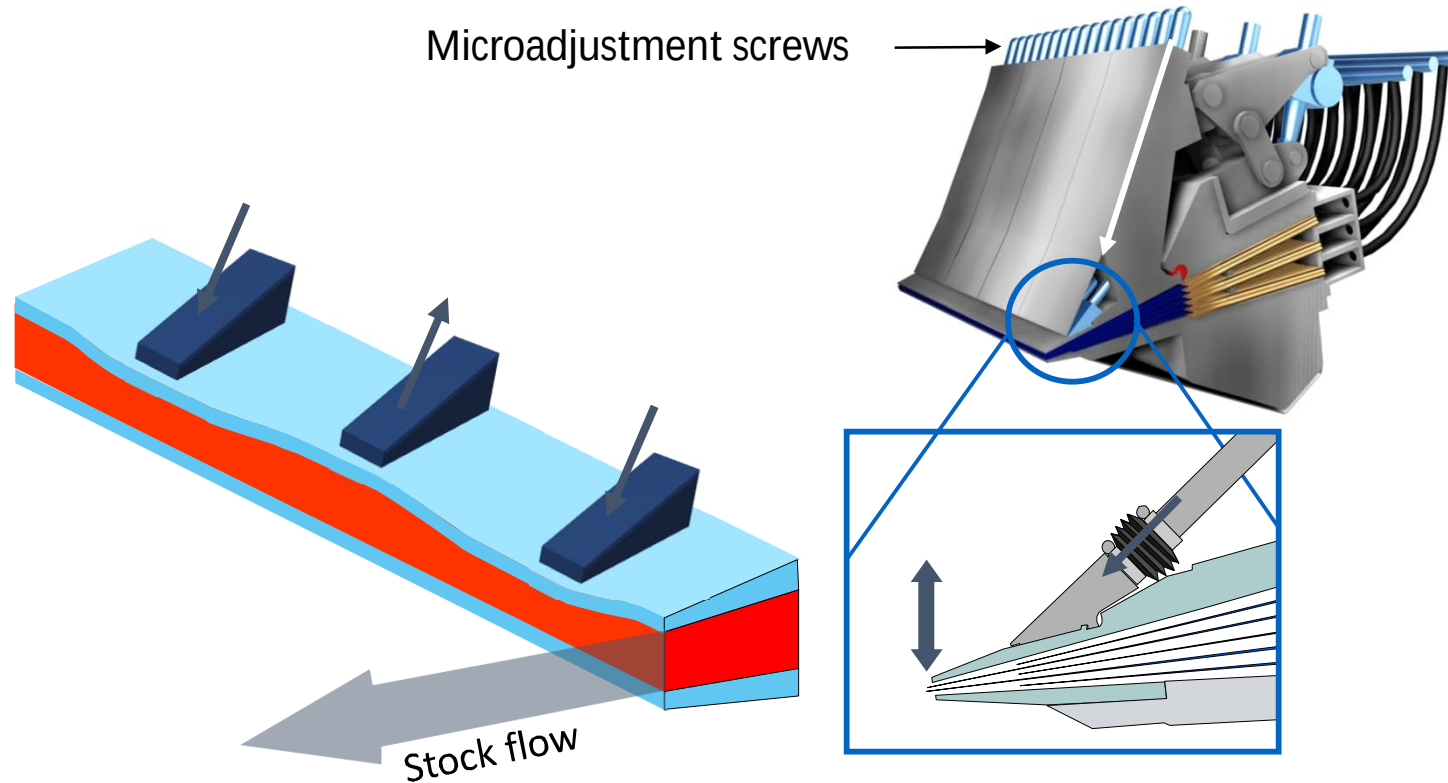
Recirculation



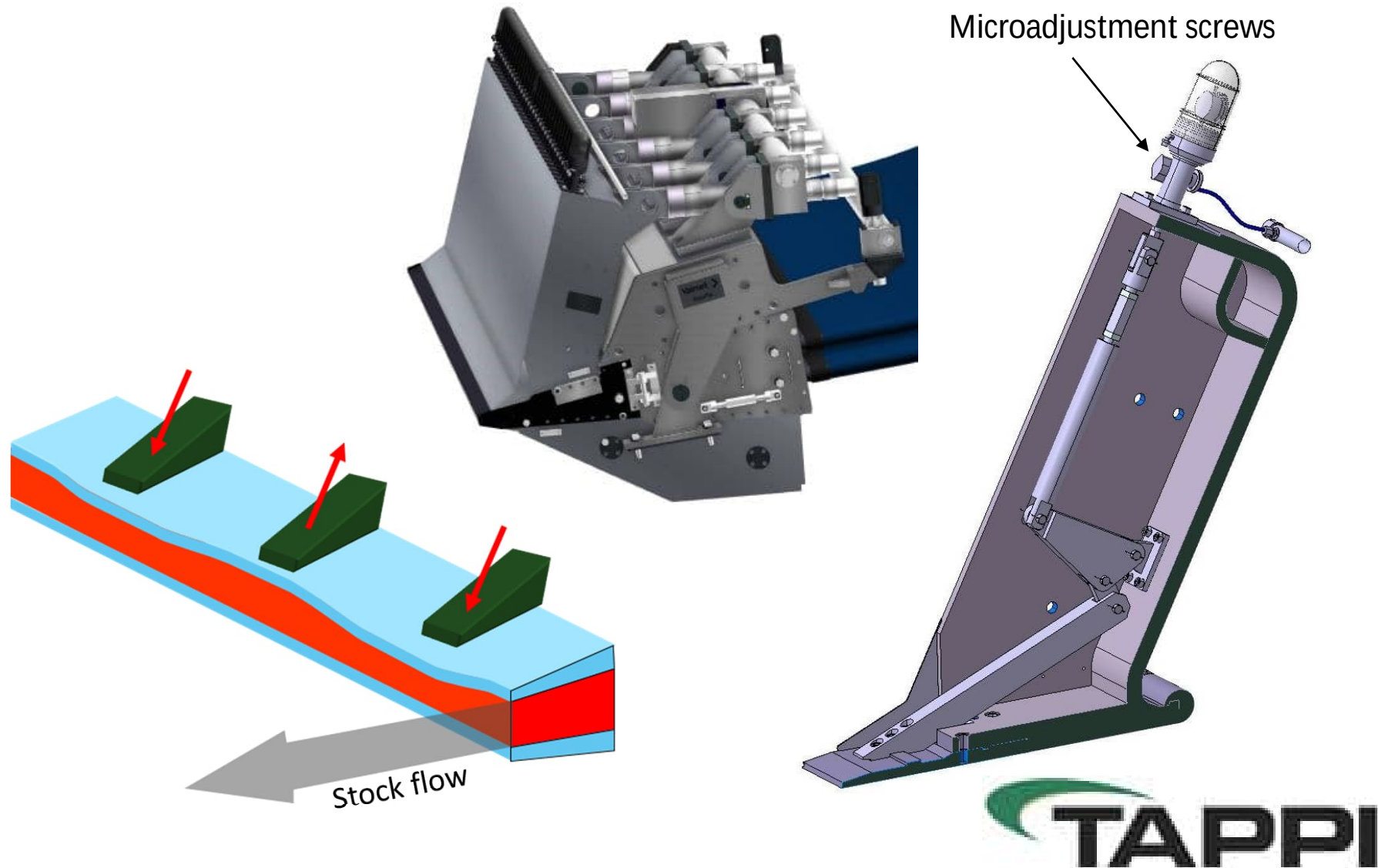
Adjustments of Basis Weight Profile (CD)

- Fixed slice
 - No adjustment
- Adjustment bolts
 - Adjusted at downtime
- Micro adjuster
 - Adjusted on the run
- Dilution Control
 - Add Whitewater into Headbox to change consistency (Manually or Automatically)

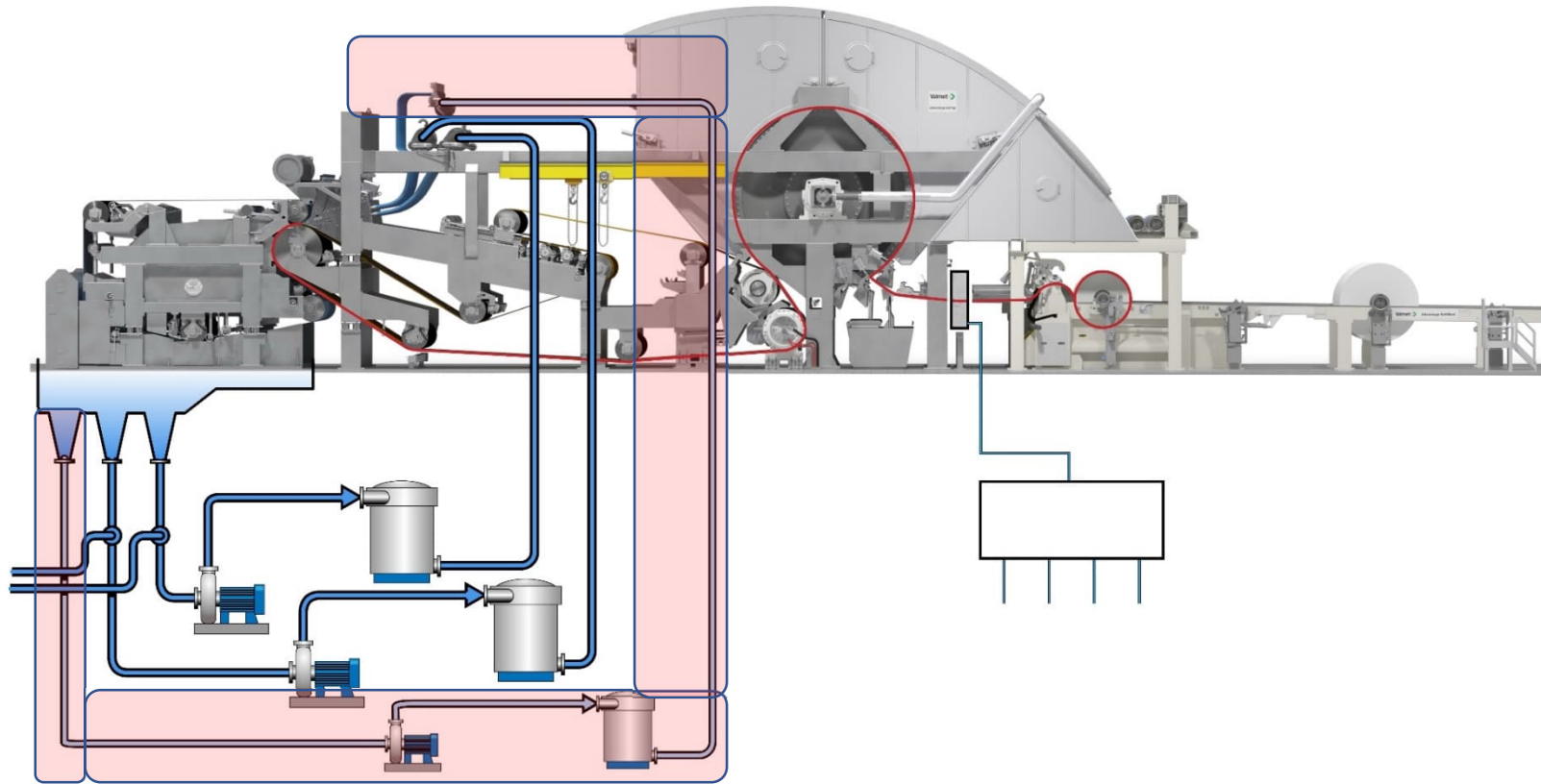
Microadjustment Equipment



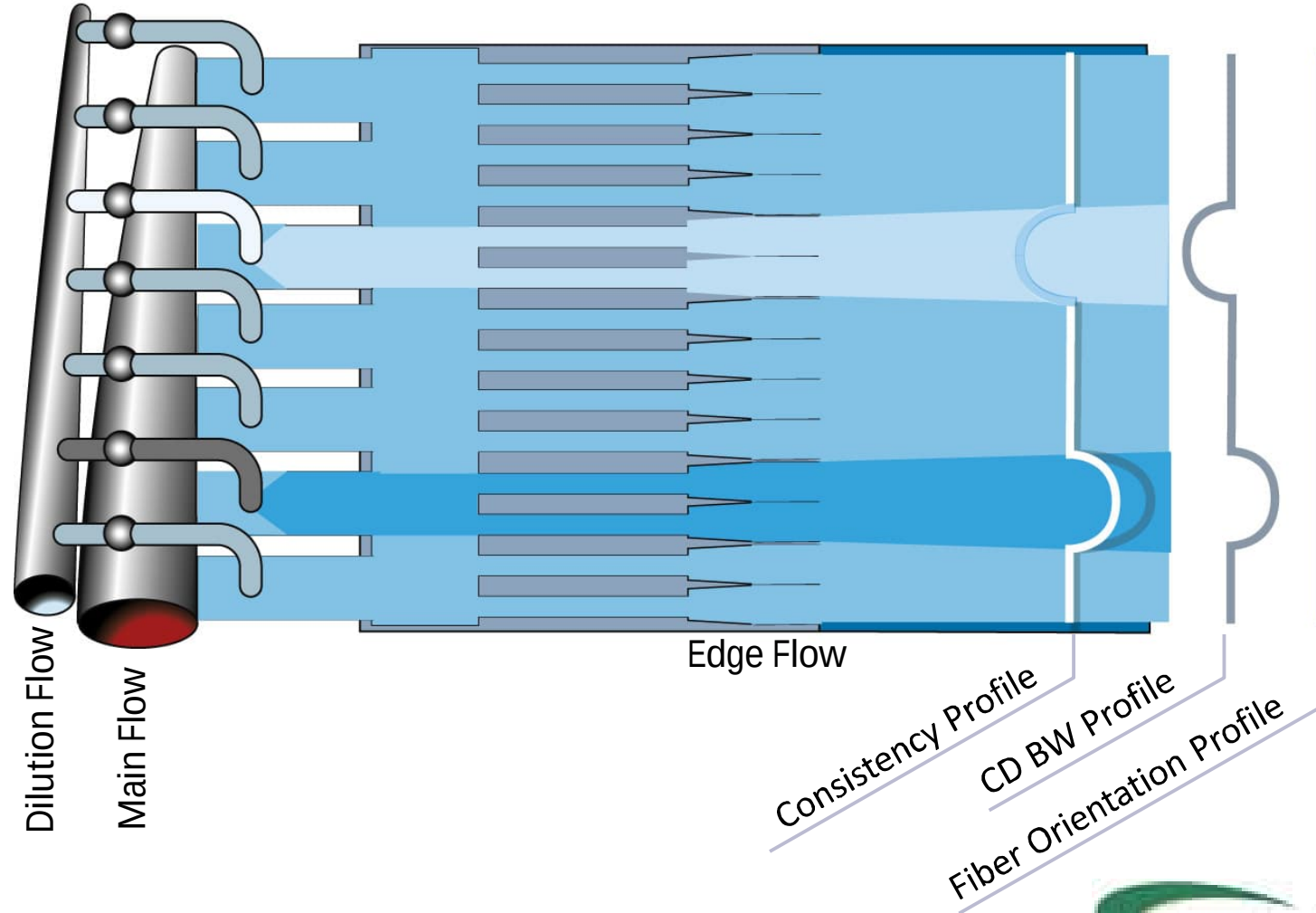
Microadjustment Equipment



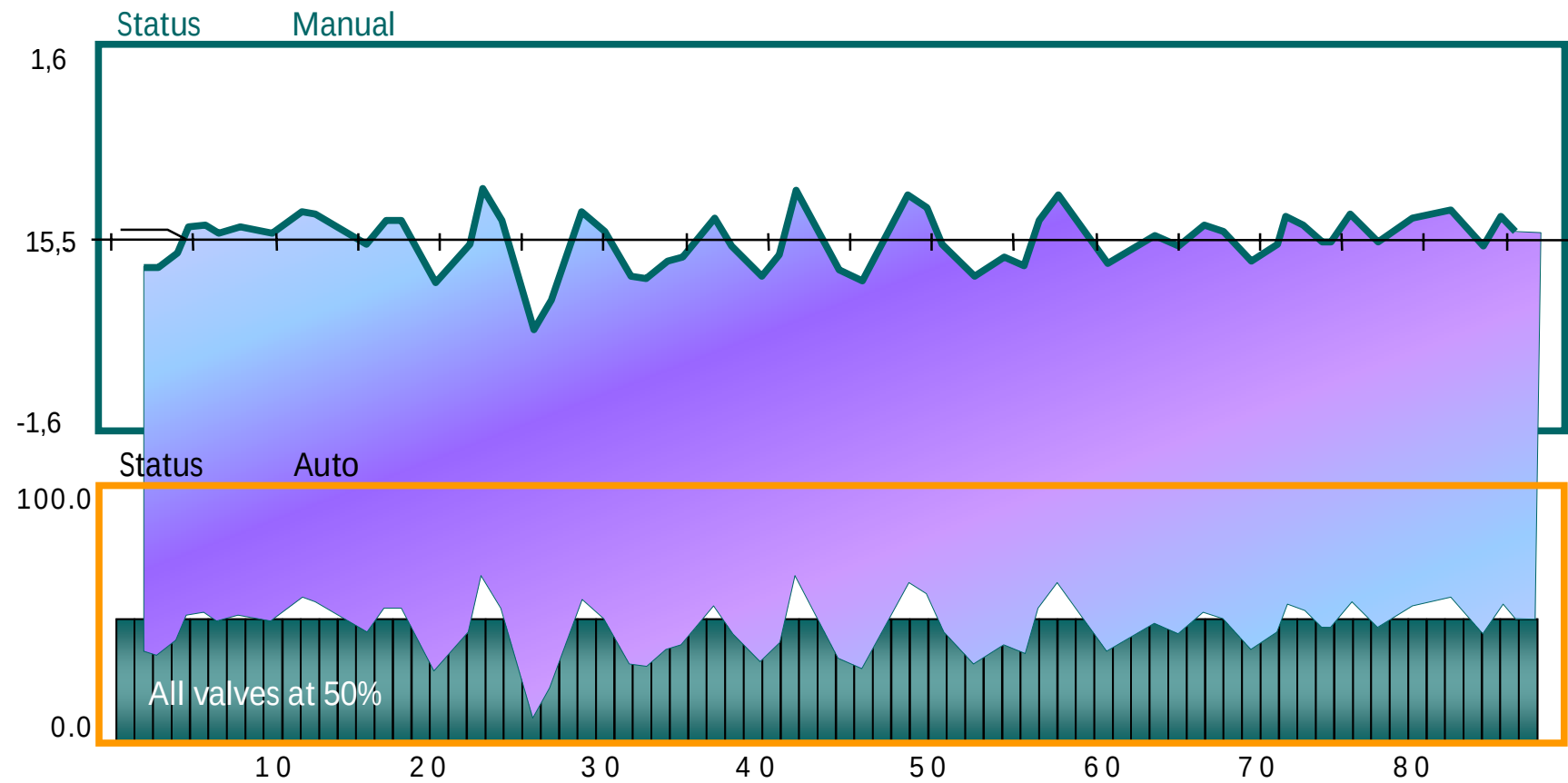
Dilution Control



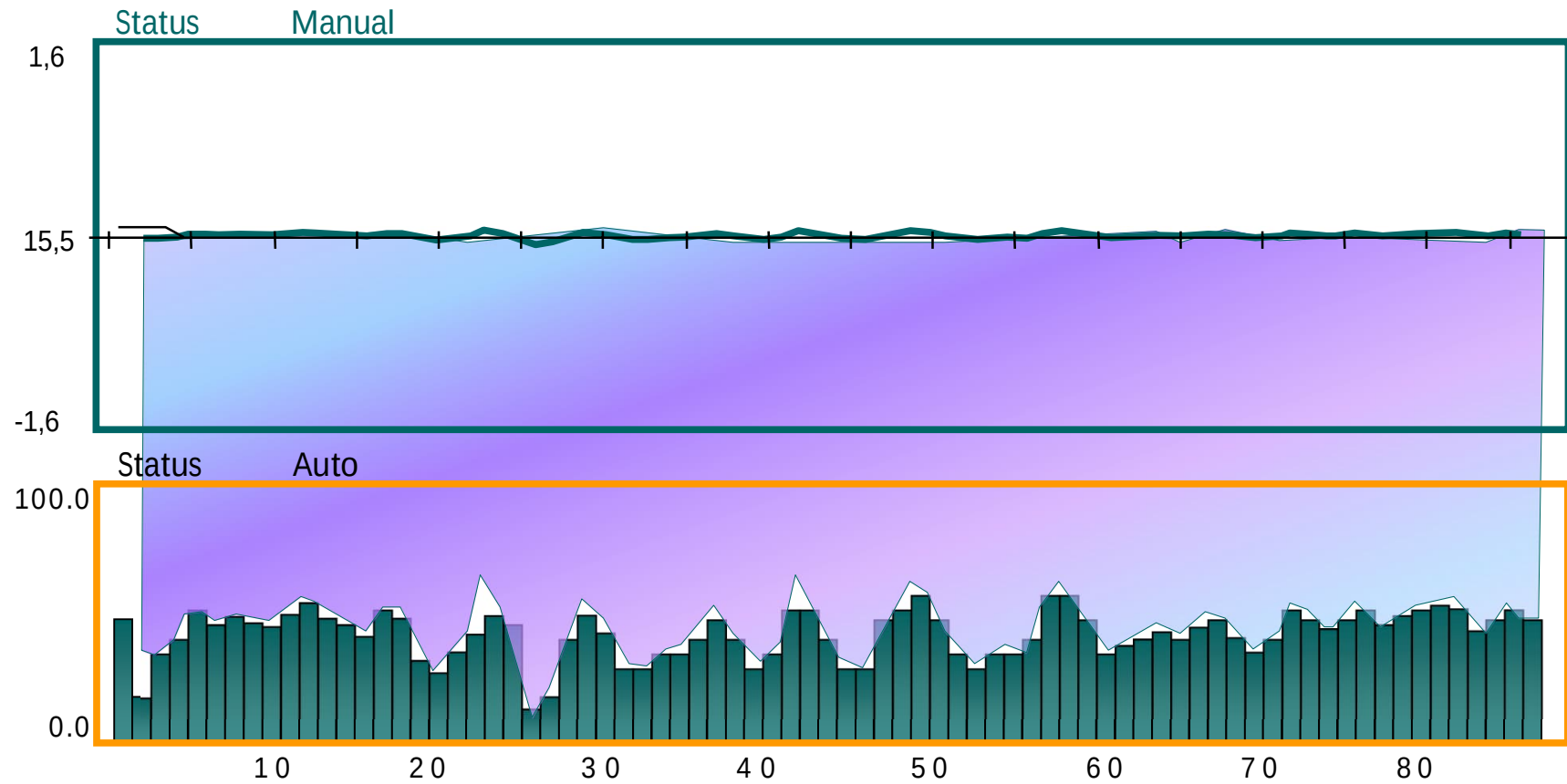
Consistency Profiling



Dilution Control



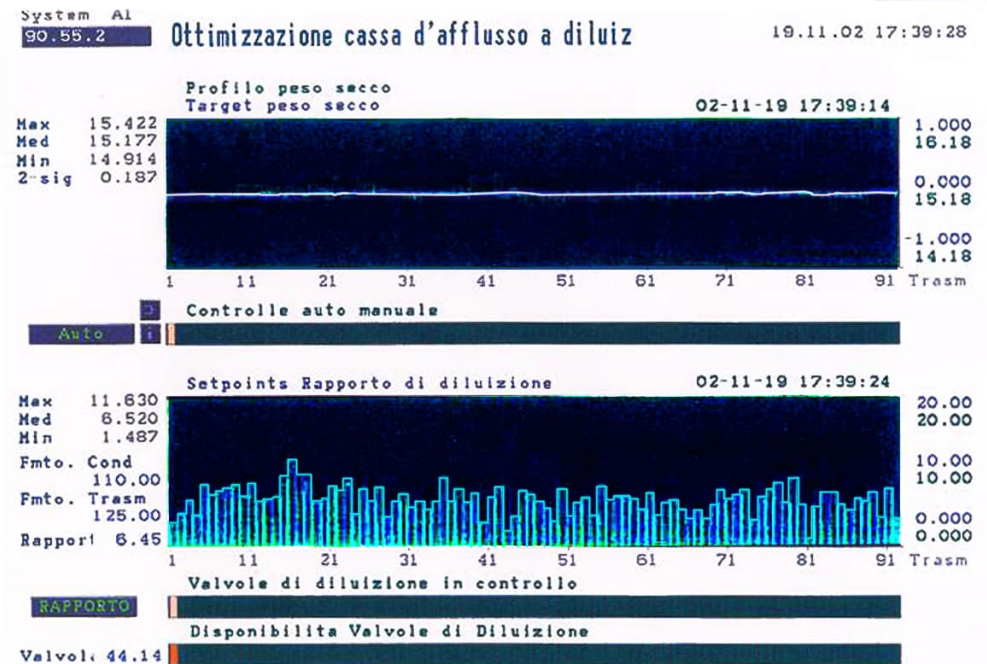
Dilution Control



Dilution Control Process

Commercial experiences show

- Better quality regarding formation and profiles
- Increased machine speed
Improved converting operation
2-sigma value of +/- 0.18



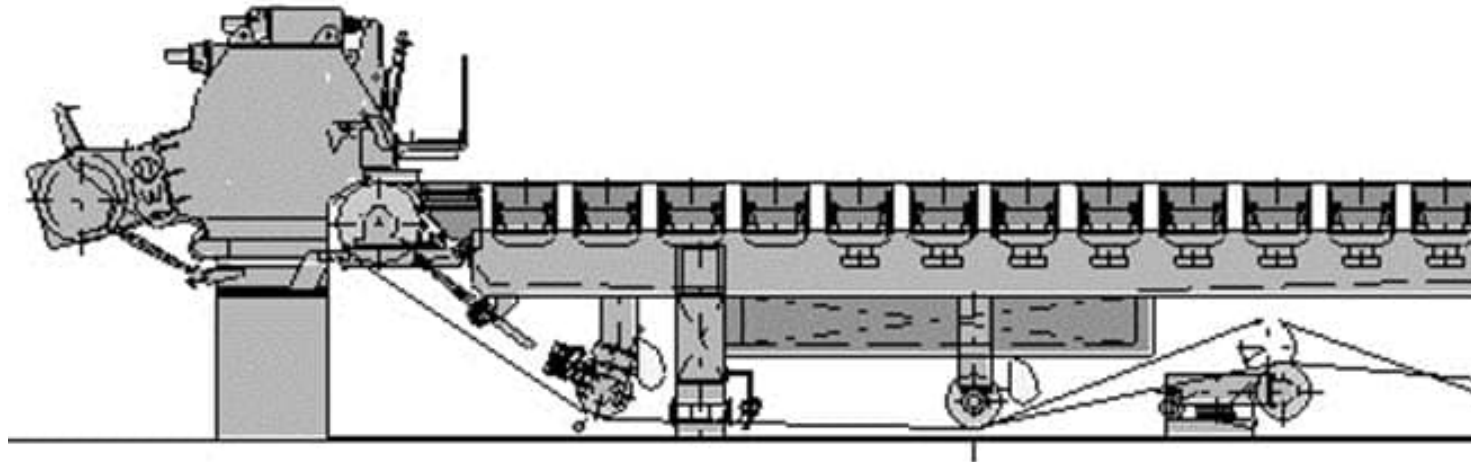
Tissue Formers

Forming section Tissue

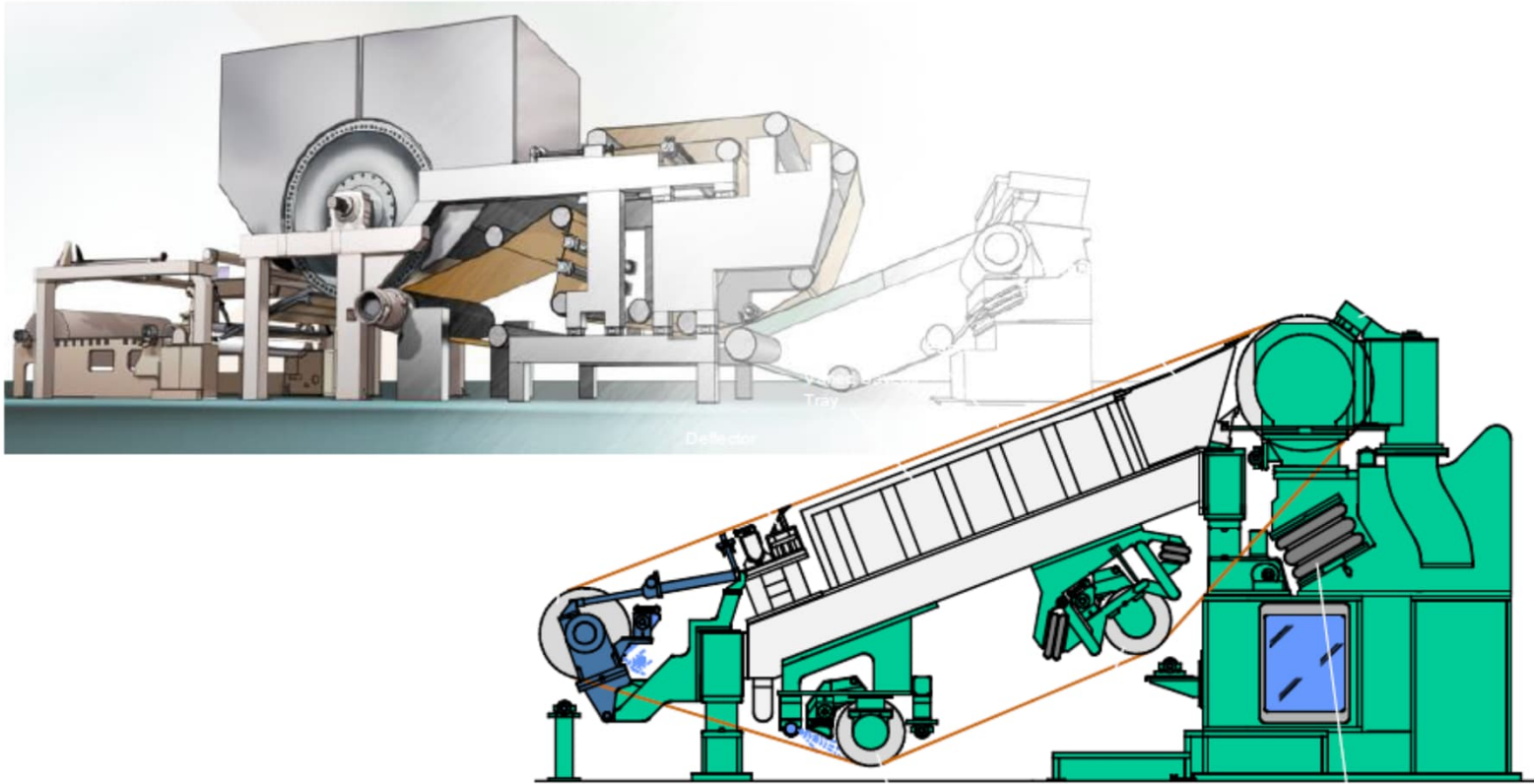
- Fourdrinier
- Suction breast roll / inclined table
- S-wrap
- C-wrap, one and two sided drainage
- Crescent former

Fourdrinier machines

- Older generations of machine
- Limited in speed & dewatering capability
- Often producing towel and napkin grades

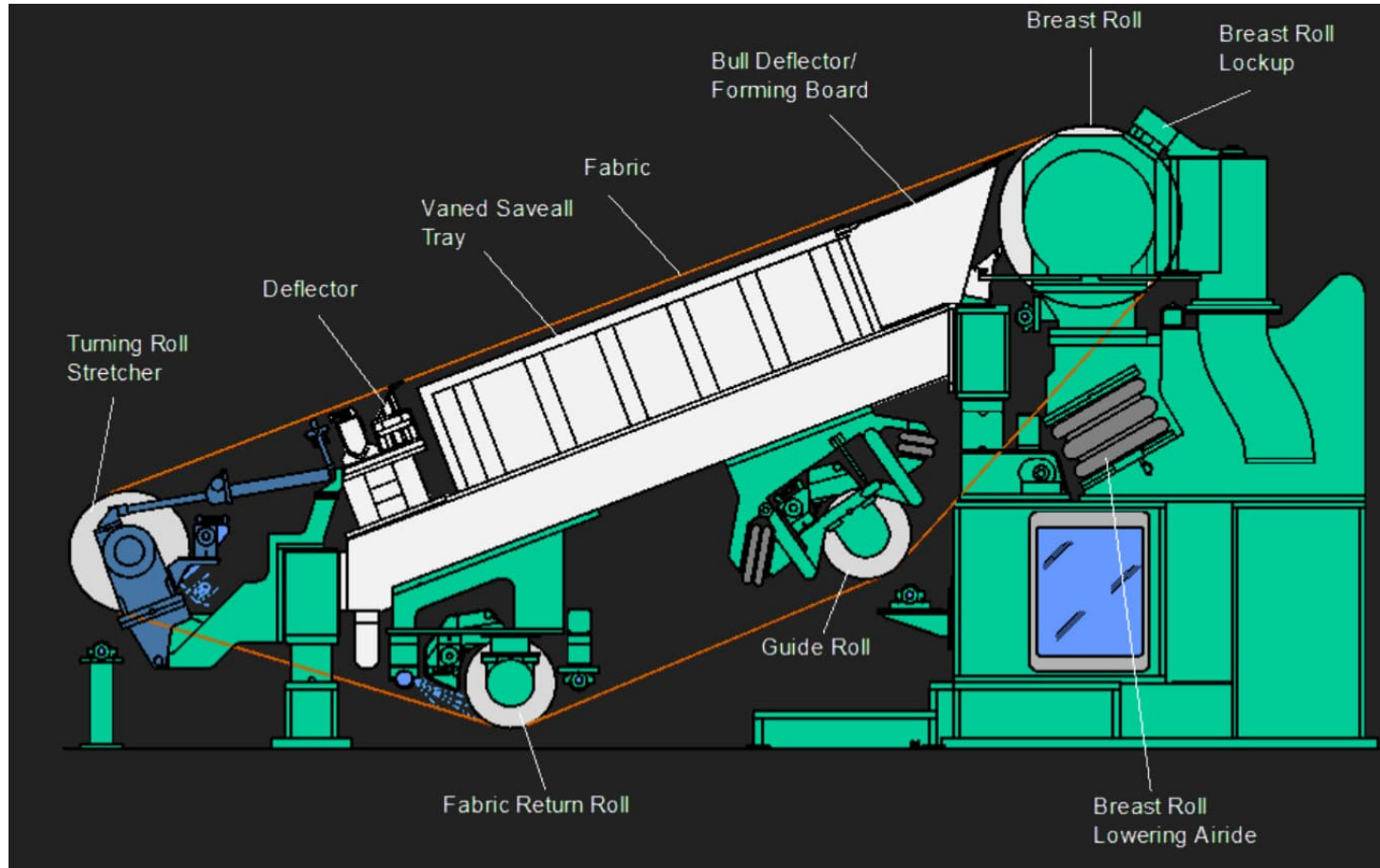


Breast roll machines



- Improved design of the fourdrinier concept.
- Vacuum assisted drainage
- Breast roll with two vacuum zones (forming and holding zones)
- Compact design
- Higher speed than Fourdrinier

Suction breast roll machines



Forming Principle – roll forming

Twin fabric dewatering

Headbox

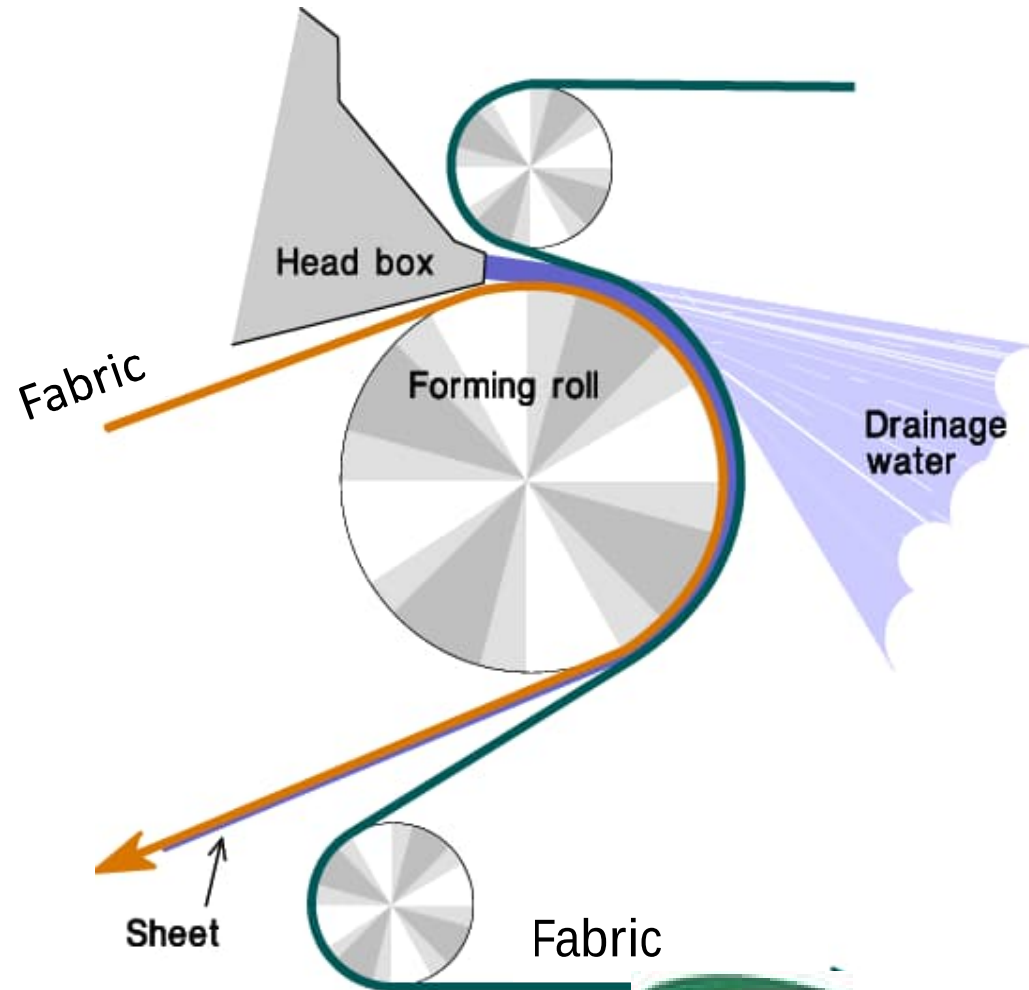
Forming Roll

Breast Roll

Form sheet between:

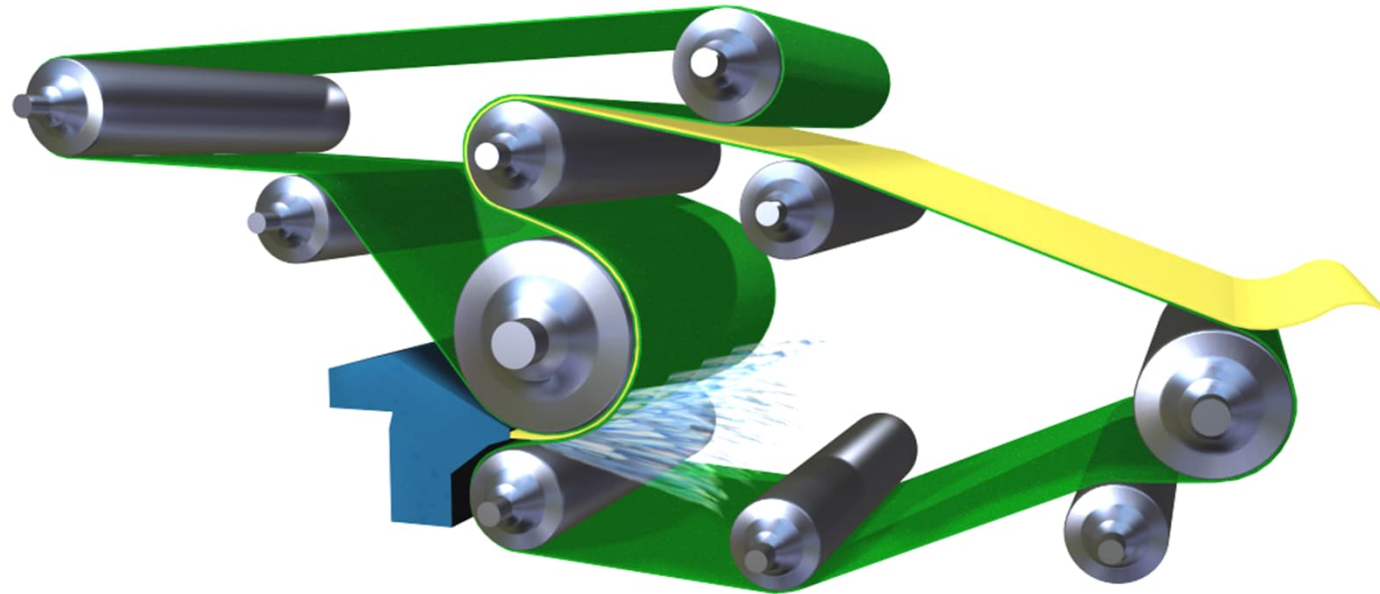
Wire and Wire

Wire and Felt



The S-Former

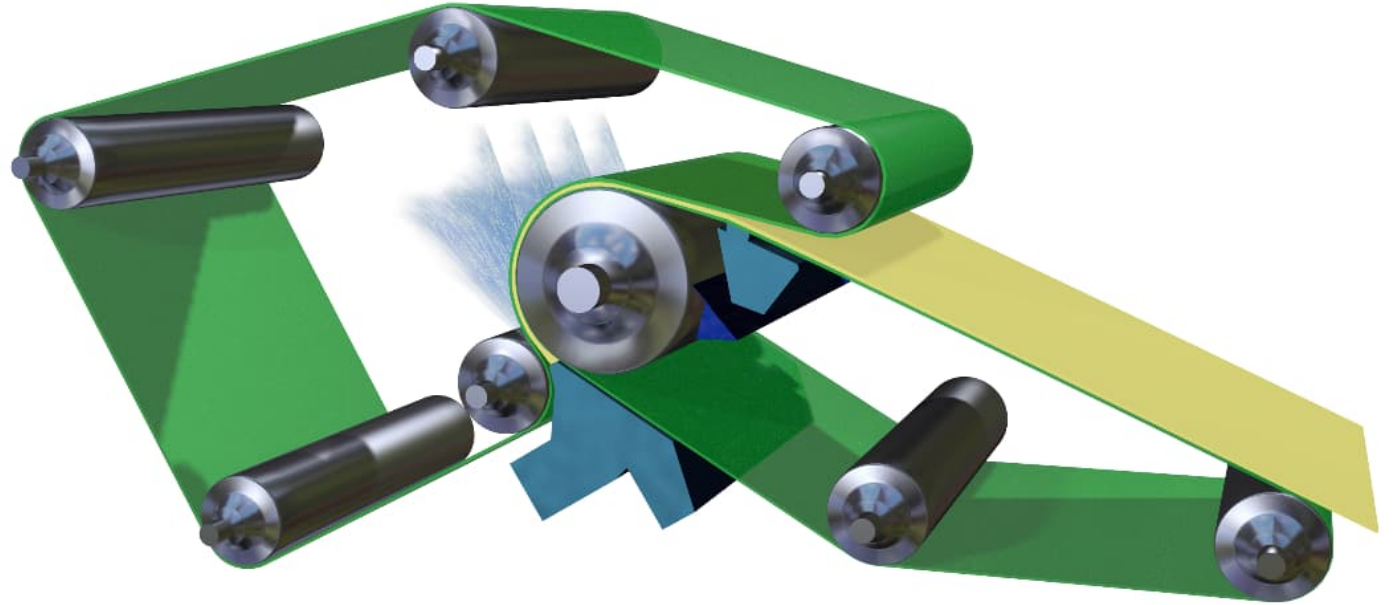
- Two fabrics
 - Outer : forming
 - Inner : support
- Forming fabric is a transfer fabric
- Lower FR diameter, which causes a second dewatering to occur (streaks or snakes' defects)
- Fabrics in sandwich
 - Fabrics can buckle leading and becoming wavy to formation defect .
 - More prone to pitch/stickies entrapment (pinholes and holes) which causes a problem on the IW due to vacuum applied.
- Good runnability up to approx. 1800 m/min.
- Good tensile index in the designed speed range.
- Rolls on paper side.
- Sensitive to fabric design combination.
- Solid Forming Roll.



Design Concept S-Former

The C-Former

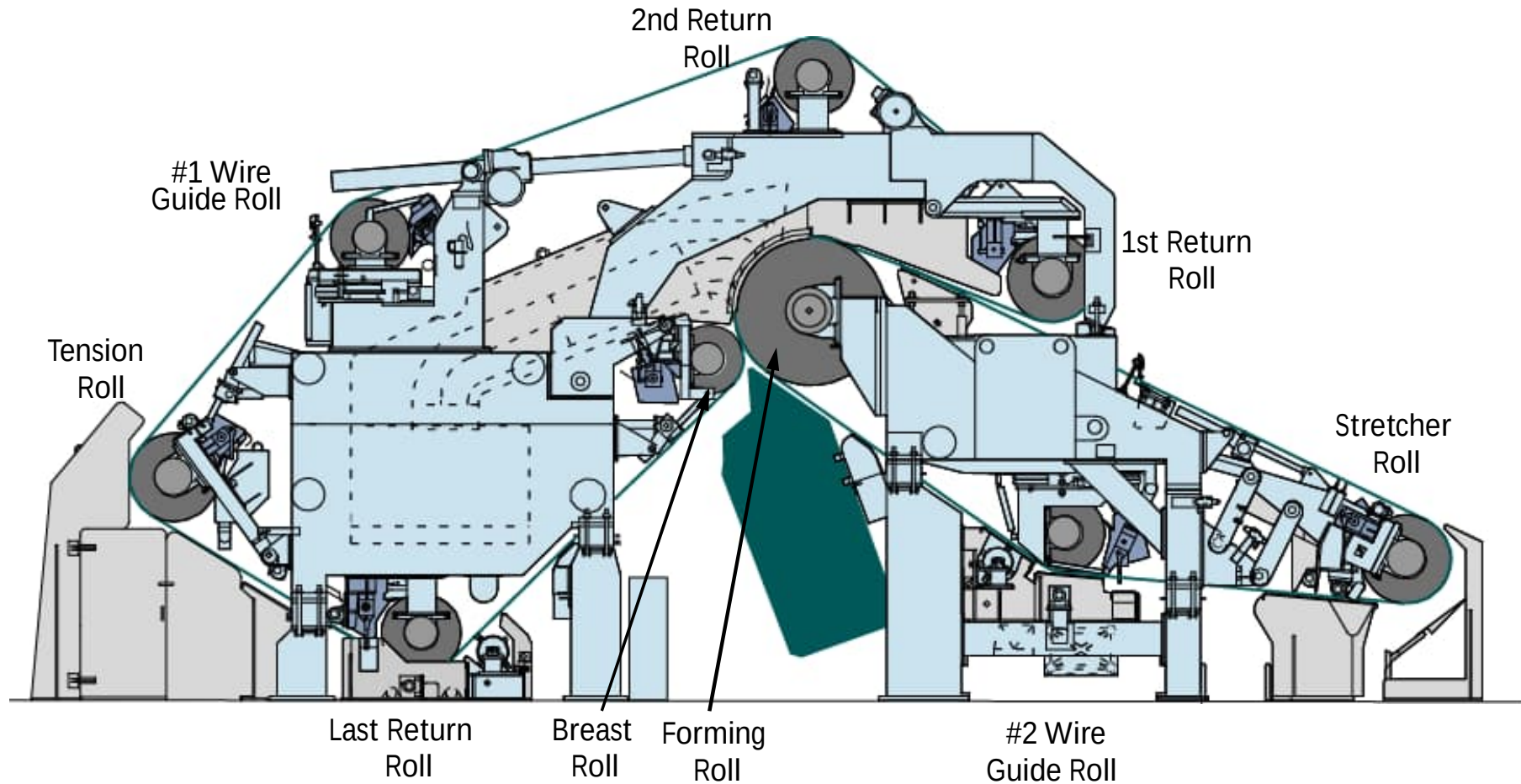
- Two fabrics
 - Outer : forming
 - Inner : support
- Sheet transferred with vacuum box.
- Open Forming Roll possible
 - Requires very high flow on HBX to fill open volume and maintain formation
 - Higher cost of operation (sleeve, drive, vacuum power, fan pump)
 - More water to be handled by the former
- Better handling of stickies compared with S-wrap.
- No known speed limitation with this former.
- Used on TAD machines and light-dry crepe machines.



Design Concept, C-former

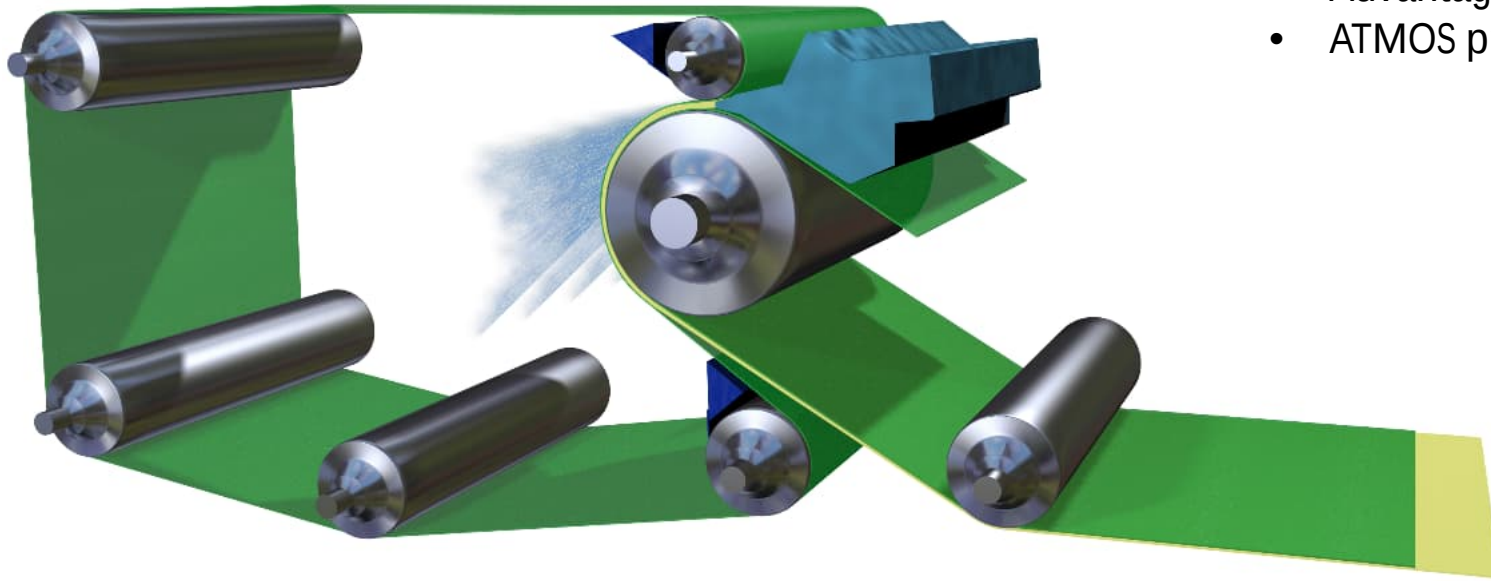
- Open Forming Roll
- Solid Forming Roll

C-Wrap Twin-wire Tissue Former



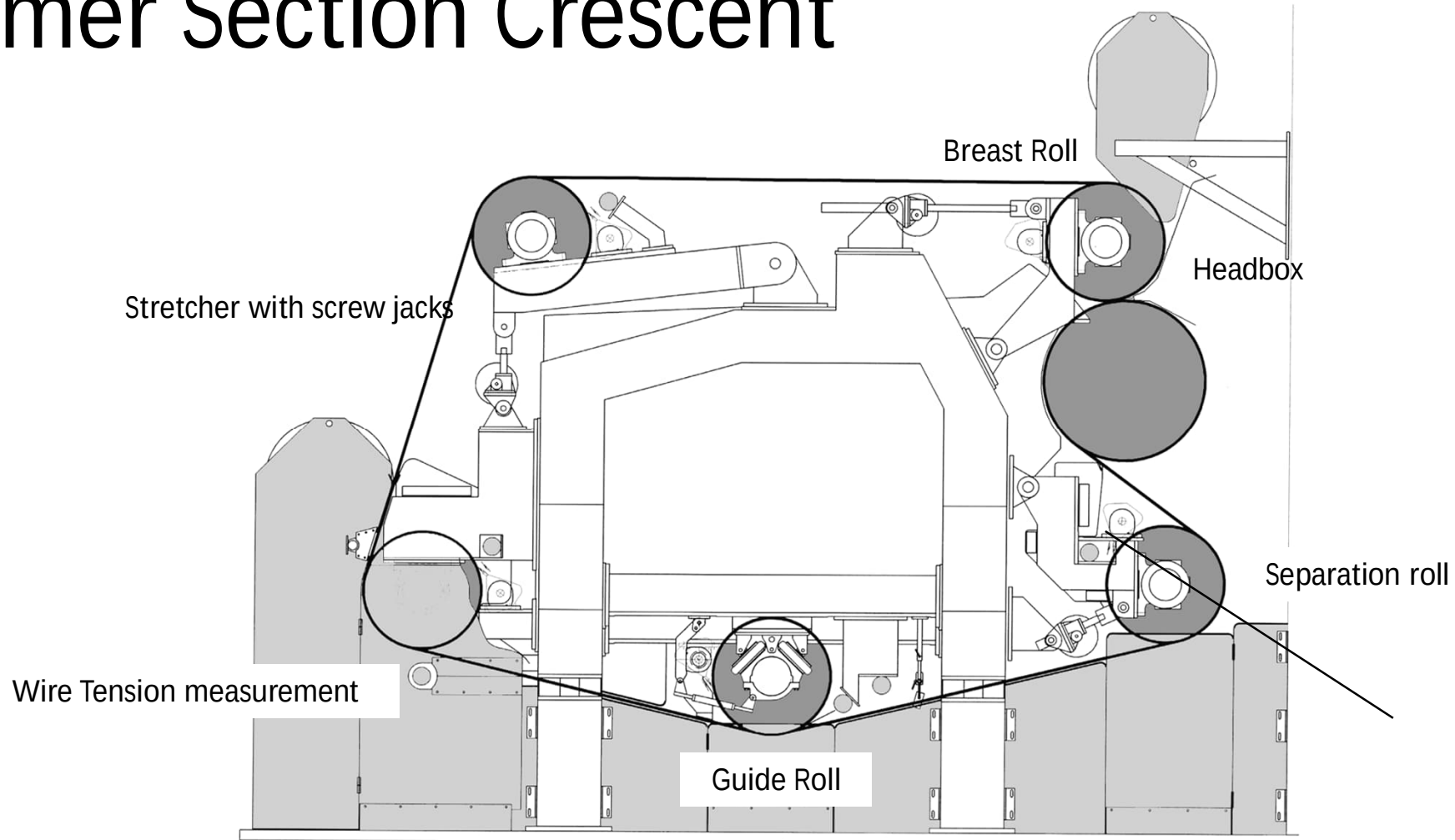
Crescent Former

- Forming in part on the felt
- No transfer
- Less space required
- Lower operating costs
- Better product performance
- Also used on hybrid machines such as
 - Advantage NTT (upside down)
 - Advantage QRT
 - ATMOS process



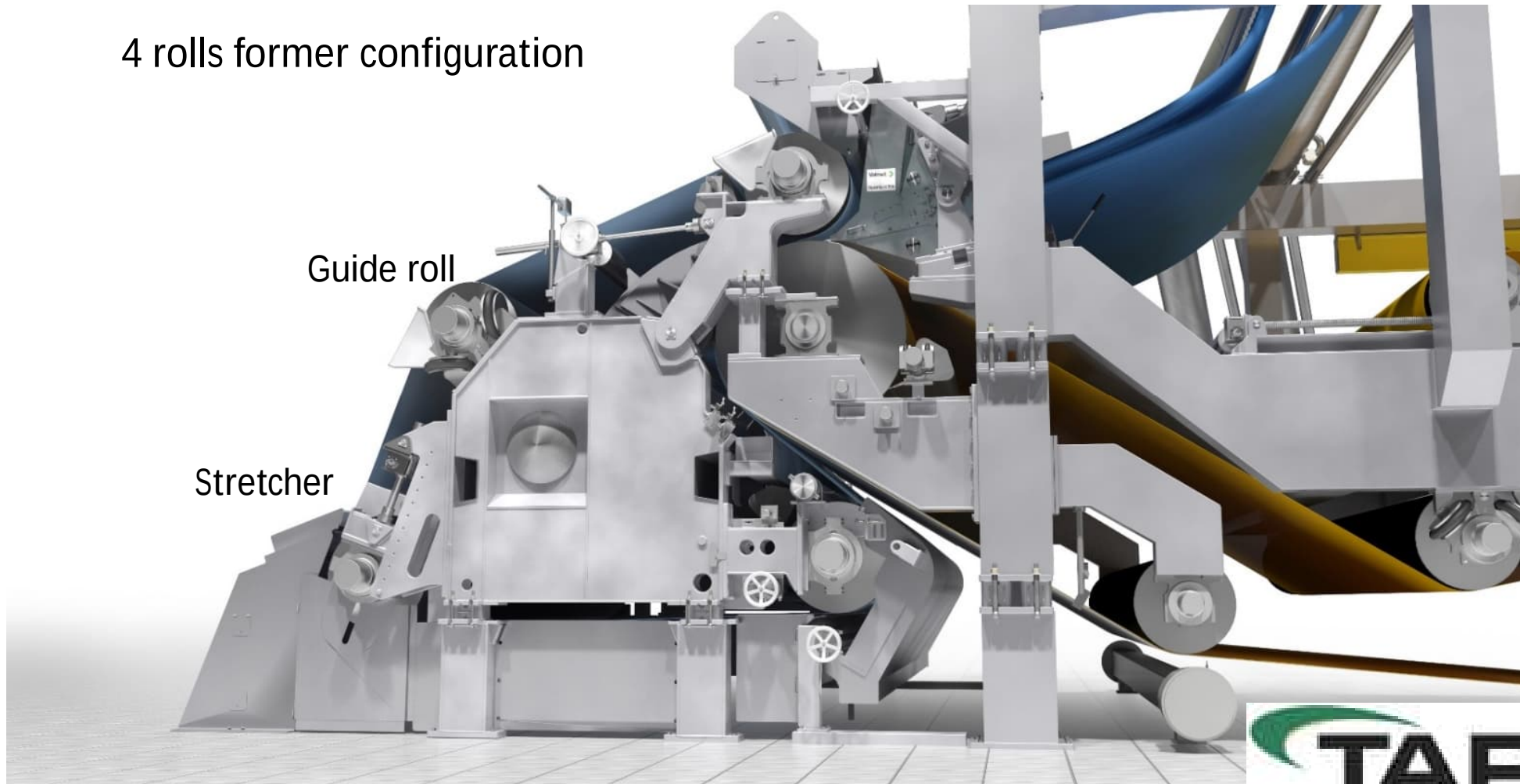
Design Concept Crescent Former

Former Section Crescent



Crescent former

4 rolls former configuration



Crescent Former benefits

- No known speed limitation
 - Are running at speeds 2200 m/min with plain forming roll
- One wire only
 - Minimum capital, operating, and maintenance costs
- One sheet transfer only
 - Maximize fiber to the Yankee dryer, best formation, minimize pin holes and pick outs
- Compact machine direction space
- Stable and repeatable geometry
- Minimum energy costs
 - No suction devices (forming or pickup), fewer rolls and doctors for lower drive requirements
- No pickup devices
 - Saves suction shoe or roll and lift/load system



Crescent Former benefits

- HIGHER OPERATING EFFICIENCY
 - Reduced wire change time (only one wire)
 - Reduced mechanical maintenance (fewer rolls, bearings, doctors, showers, etc.)
- IMPROVED PRODUCT PERFORMANCE
 - Improved lightweight sheet appearance (result of one less transfer)
 - Lower number of sheet defects
 - Pin holes - Openness of sheet
 - Pick outs - Caused by wire contamination
 - Pick outs - Caused by pick-up



Forming section alignment



- S-shape of tradeline indicating that one or several rolls or a stationary element in forming section is/are misaligned.
- Consequence can be even drainage and difficulties at guiding.
- Indicate that wire loop is longer on one side vs the other (misalignment of a roll or screw jack not even lengths)

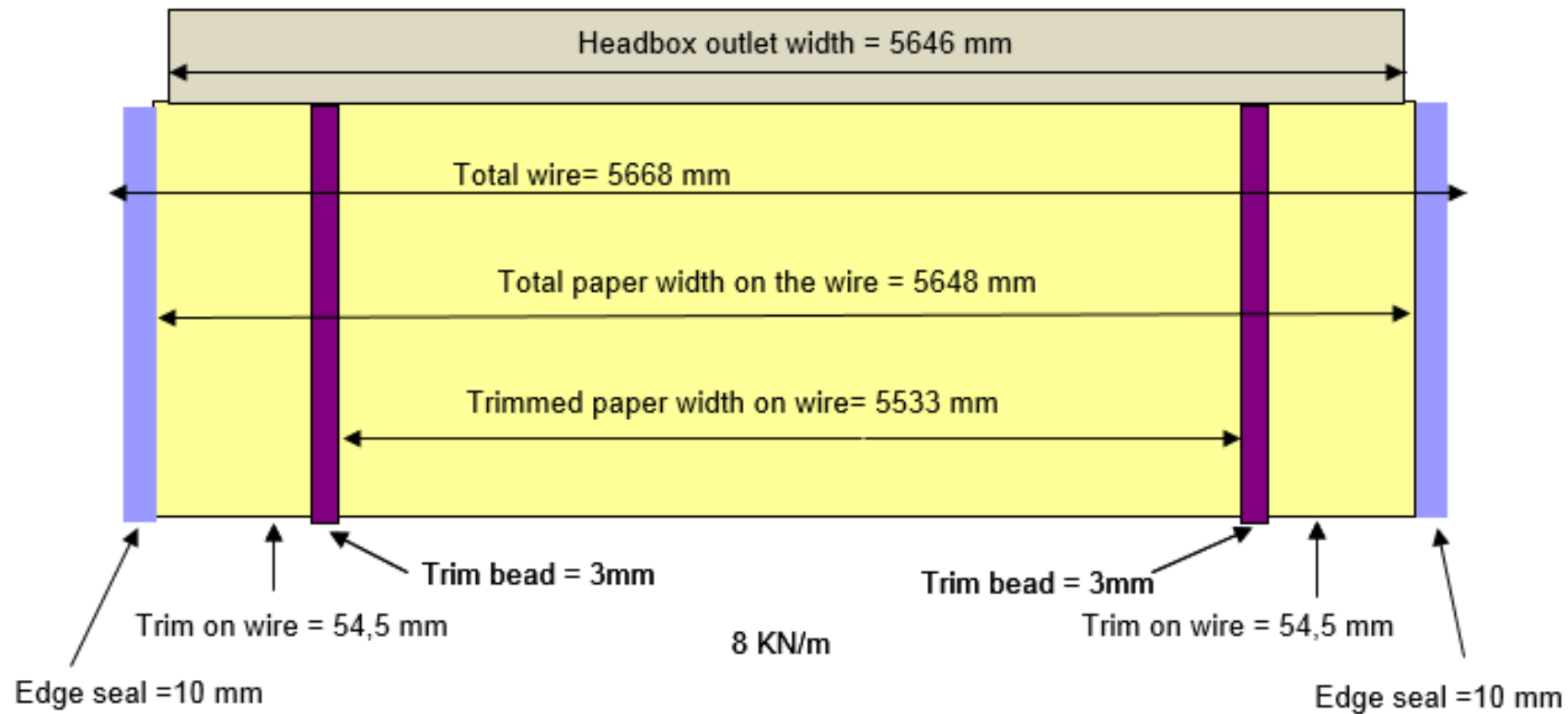
Forming section alignment



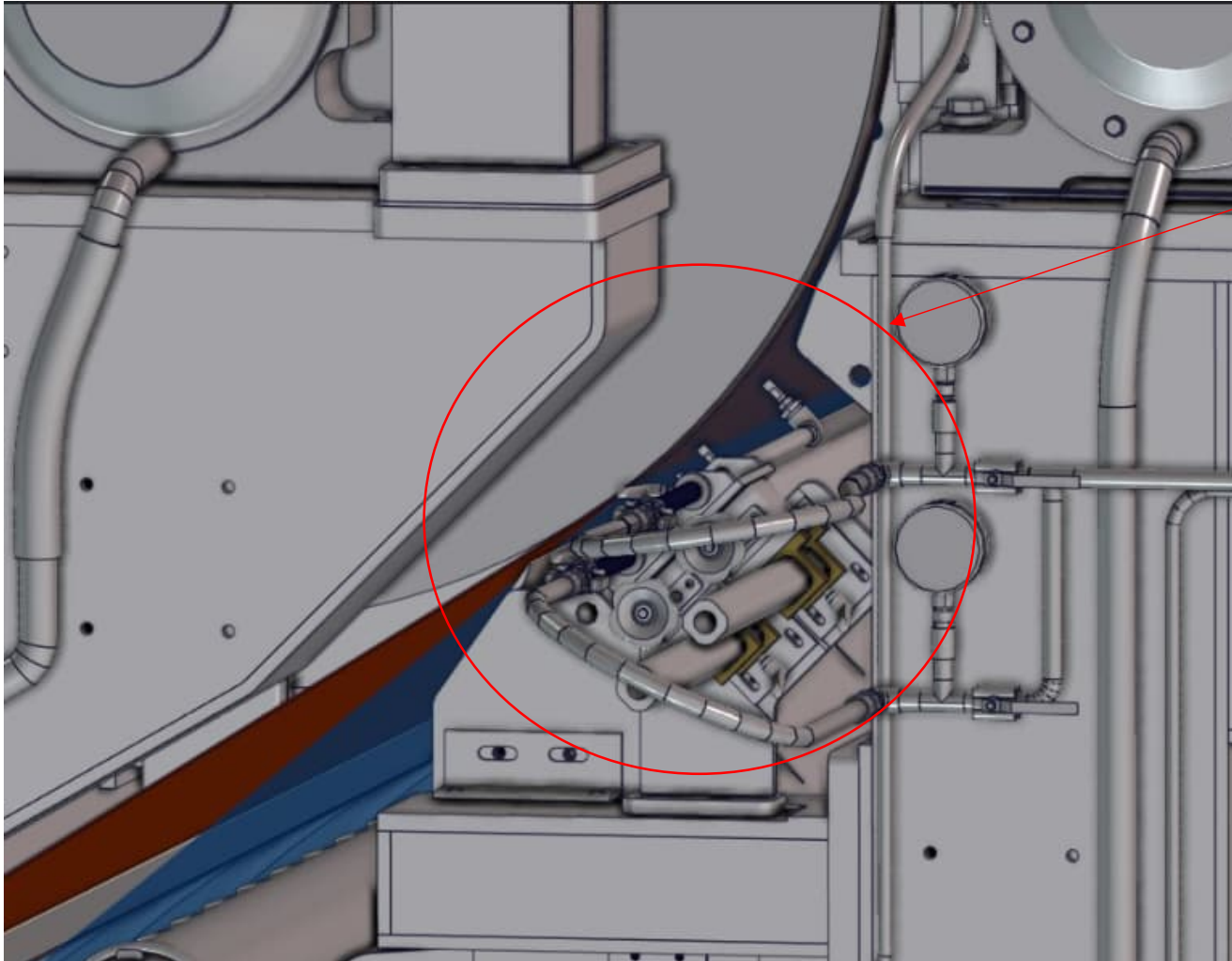
The way is should be :

- Straight line
- Even wire (no streakiness)

Trimmed paper with trim bead's



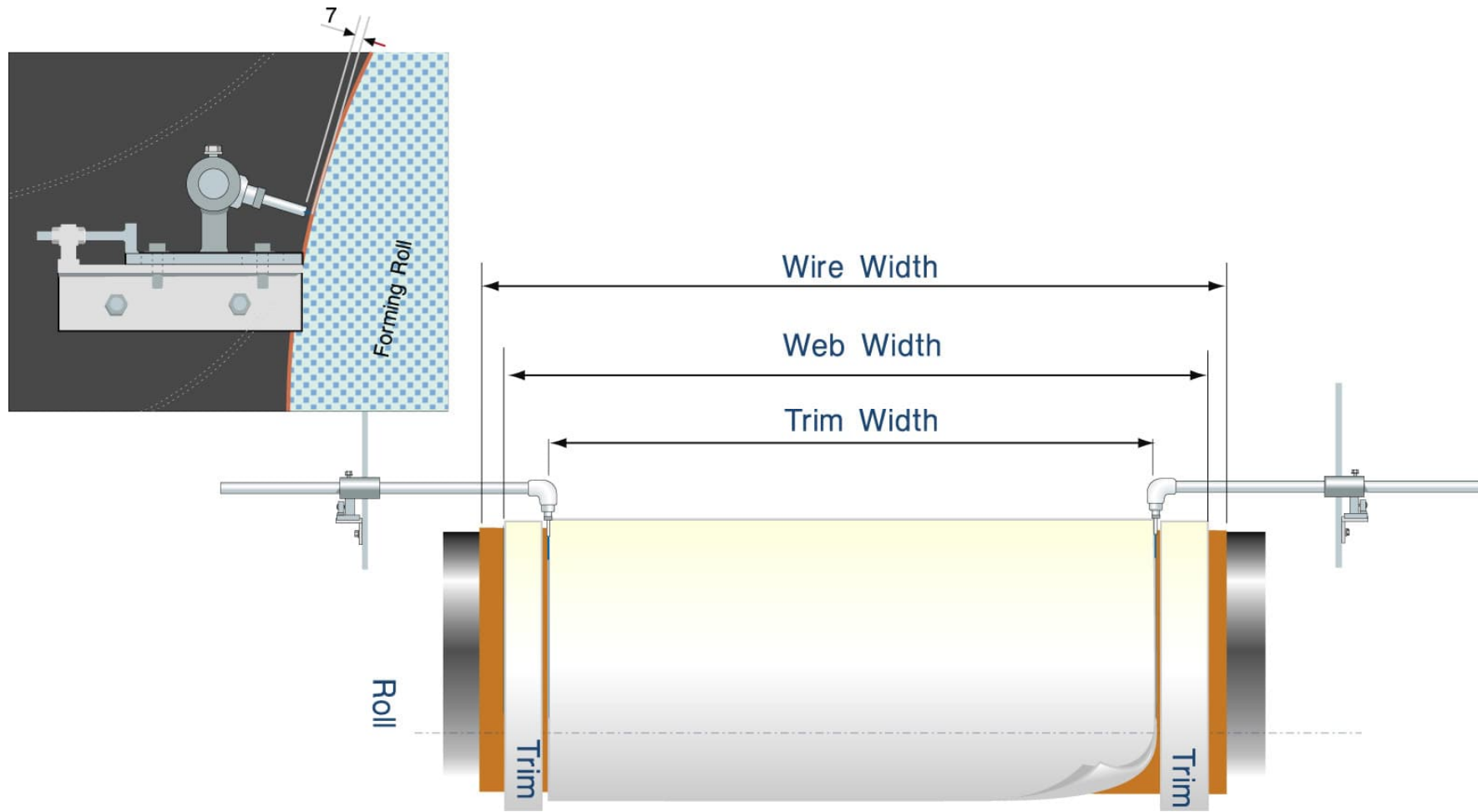
Alternative : trim squirt nozzles



Trim operation is made at the forming roll.

Just is passing through the forming wire and cut the sheet onto the felt, just prior to the separation of the two clothing.

Alternative : trim squirt nozzles



Trims nozzles on TAD machines



- Trimming occurs on the Inner wire :
 - After steam box and tail cutter
 - High pressure is required since sheet is about 20-22% dry at that stage
- Outer trim :
 - Must align with transfer box deckle and TAD deckle band
 - Possible to have one bead on one side, but keeping a degree of freedom is recommended due to fabric narrowing as it ages, tension, rush transfer condition
- Inside trim:
 - Dictated by converting sheet width requirement
 - Bead not recommended as sheet width can change depending on grade, fabric and rush transfer condition



Thank you

PRESENTED BY

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